9-G-124

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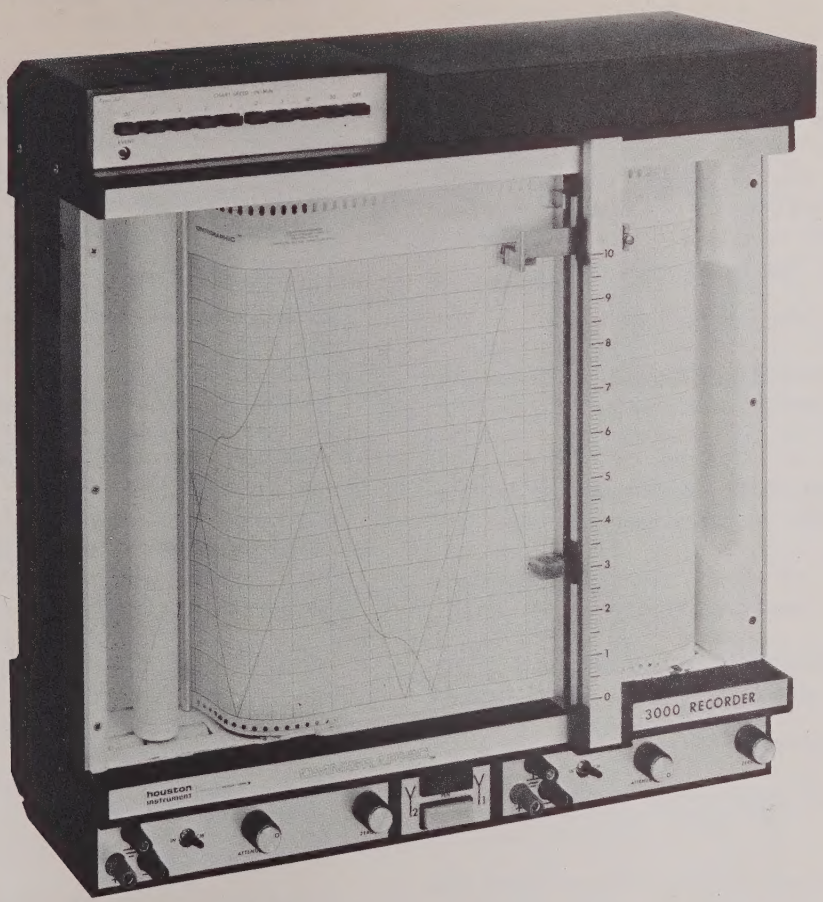
4950 TERMINAL AVENUE, BELLAIRE, TEXAS 77401

Recorder Serial No. _____

SERIES 2–3000
OMNIGRAPHIC®
TWO PEN STRIP CHART RECORDER
INSTRUCTION MANUAL



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DIVISION OF **BAUSCH & LOMB**

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IM2–3771

SPECIFICATIONS

Chart (X) Axis

CHART MECHANISM: Either stepper motor or synchronous drive depending on original choice. (See model number description.)

ACCURACY: Absolute, depending upon line frequency fluctuations.

CHARTS: 100 foot chart rolls, 12 inches wide with 10 inches or 250 mm writing width.

CHART FEED: Roll take up or positive paper feed, depending on operator choice.

CHART SPEED: Single speed for synchronous units. Type 52 chart drive module used with stepper units provides pushbutton selection of nine fixed speeds; 20, 10, 5, 2, 1, 0.5, 0.2, 0.1, 0.05 inches/minute. Remote on/off or start/stop via terminals supplied. For remote operation, external pulses or shorting action will advance paper one step per actuation up to 200 steps per second. Pulse must be > 5 volt positive going into 10K ohm load. 360 pulses give 1 inch paper traverse on 60 Hz. recorder (300 pulses on 50 Hz. units).

Pen (Y1 and Y2) Axes

RECORDING MECHANISM: Potentiometric servo with sealed rebalance potentiometer. Long life, snap-in, disposable pen.

INPUT CHARACTERISTICS: Differential and floating to ±500 VDC or peak AC above ground.

RESPONSE TIME: 1/3 second maximum independent of line voltage or frequency. Optional — 1/4 second.

ACCELETATION: Acceleration is > 1500 in/sec^2 (3750 cm/sec^2) on 1/3 second instrument; > 1800 in/sec^2 (4500 cm/sec^2) on 1/4 second instrument.

OVERSHOOT (Damping): Less than 1% on full scale steps. Not discernible on half scale or less steps.

ACCURACY: ±0.2% of full scale.

LINEARITY: ±0.1% of full scale.

REPEATABILITY: ±0.1% of full scale.

RESETABILITY: ±0.05% of full scale.

STANDARDIZATION: Continuous double regulated zener with temperature compensation (±0.0025%/°C).

COMMON MODE REJECTION: On most sensitive range: 140 db at DC; 140 db at line frequency with up to 1K source resistance. Decreases 20 db per decade of attenuation for both AC and DC.

General

PEN LIFT: Electric — local or remote control (via terminals supplied), both pens simultaneously.

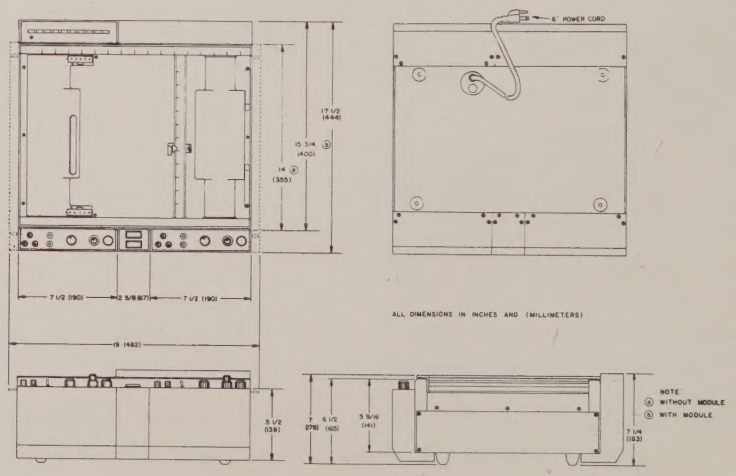
EVENT MARKER: Electric — local or remote control (via terminals supplied).

MOUNTING: Bench, rack, or panel — horizontal or vertical. See detail below for dimensions.

WEIGHT: With modules, 34 lbs. (15 Kg); shipping 38 lbs. (17 Kg).

ENVIRONMENTAL: 10 to 30°C operating. −10 to 60°C storage; 0–95% relative humidity at 30°C dry bulb.

POWER: 115/230 VAC ±10% single phase, 50 or 60 Hz., 50 volt amperes. Specify frequency for correct chart speeds.



OPERATION

After loading the paper and installing the pens, the recorder is ready to operate. Certain points should be noted:

a.) The event marker is interlocked such that no mark is drawn until the recording pens are down. A continuous line is then drawn until actuation of the event marker.

b.) Positive paper feed will work well on a level surface until 10 – 15 feet of paper have been fed out. The paper will then tend to fold back on the recorder. If long positive feed traces are desired, position the record at a surface edge and let the paper feed to the floor. No weights or pulls are necessary.

c.) The recording pens are electrically operated from either the front panel or remotely. Do not try to snap pens up manually.

d.) The recorder may be positioned on its back, front side or completed trace end for roll take up or positive paper feed out. Rack mounting allows only roll take up operation.

RECORDING CONSIDERATIONS

The 2–3000 Recorder vastly reduces the care and considerations normally required for successful applications. Typically – high common mode rejection allows the recorder to ignore careless signal leads, lack of source isolation, environmental ground loops, etc. High input resistance favors many different kinds of sources. The fixed nature of the recorder input resistance removes interaction with the source. Differential input allows lead reversal for drive direction, plus the ability to record differences between signals at different potentials. Very high acceleration and velocity with critical damping give "true" portrayals of inputs.

Yet, these high tolerances do have limits. The following comments are a series of various and sundry points to consider when recording. They pertain to all aspects of recorder performance, plus some thoughts on extending the recorder's life.

VOLTAGE PROTECTION: All ranges have overload protection to 500 volts. Therefore voltage magnitude and polarity need not cause concern when connecting. On an unknown signal, simply connect and use the module attenuator and zero controls to establish magnitudes and polarities.

VOLTMETER: With $\pm 0.2\%$ full scale accuracy and an expanded scale, the unit is an excellent analog DC voltmeter. The scale can easily be read at a distance – the paper at close distances. It is not necessary to record.

OPEN INPUT: With no signal the recorder will tend to hum. This is due to the high input resistance and high frequency response of the unit. Although this does not hurt the recorder, extended periods could tend to reduce life. Either short or turn it off. (All solid state circuitry gives instantaneous calibrated operation when turned on).

CLEANLINESS: The mechanics are extremely tolerant of dust and contaminants. Yet grime can detract from operation due to excessive build-up. So keep it clean if for nothing more than good housekeeping and aesthetics.

TEMPERATURE AND HUMIDITY: The recorder has a wide tolerance, BUT paper does not. Maximum accuracy with linear results is achieved only if paper environment is kept relatively constant during the entire length of recording. A few degrees change in temperature can cause a non linearity. Typically a $10^{\circ}C$ change can cause as much as 1% paper non-linearity (i.e., the paper grows during recording – when equilibrium is reached, the ultimate trace has a 1% non-linearity in the portion affected by temperature change).

ADJUSTMENT: Don't adjust gain or calibration when the recorder first appears to be operating incorrectly. First, check:

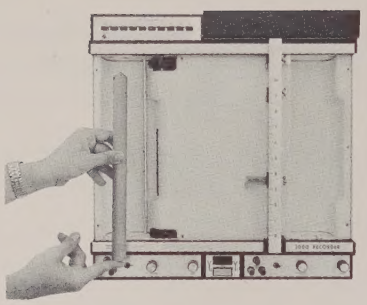
a.) Input is open – as mentioned before, a high frequency hum can occur due to the recorder's high resistance and frequency response. Short the input to check.

b.) Insure that no noise has been picked up in the signal.

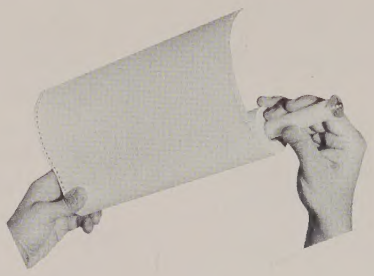
c.) Check for high level, high speed transients in the signal.

DATA (Extra or Missing): Omission of expected signal spikes can be that they are too fast, or previous recorders had overshoot, which actually introduced data not present. (The 2–3000 is critically damped.) With its high frequency response, the 2–3000 is going to portray signal data or noise that some prior recorders couldn't. It's accurate; just missed before, due to either low acceleration or speed.

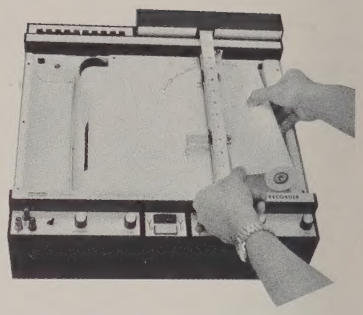
LOADING PAPER



Insert shaft in core noting correct end.

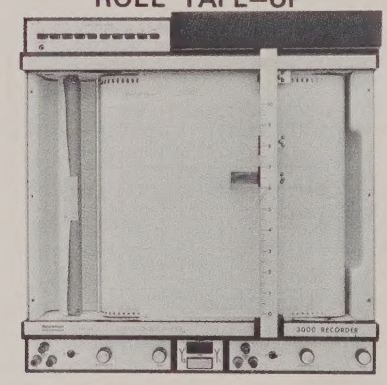


Slip shaft (DO NOT DROP) in paper roll. Cardboard core must remain flush with paper. Note flange with reference to slots in paper.



Snap roll in right side of recorder pushing upward.

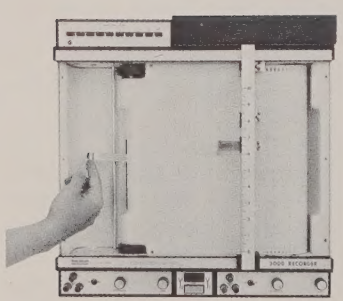
ROLL TAPE–UP



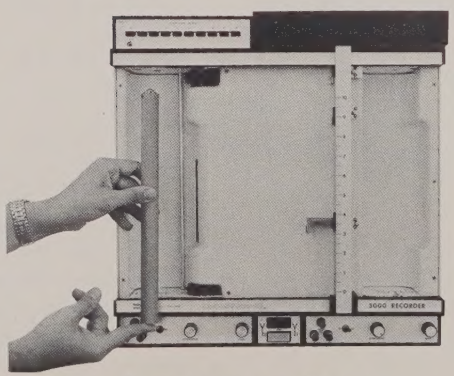
Thread paper under beam and paper guide. Tape end to cardboard core keeping paper flush with core end (core left over from previous roll). Note paper winds under core.

POSITIVE PAPER FEED

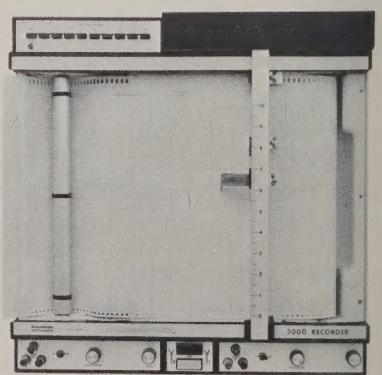
Follow top three steps and then:



Rotate spring bar out.



Insert shaft in roller.



Pull paper out across spring bar and snap roller over paper with shaft pin in correct position.

PEN LOADING: The pen includes both pen tip and ink supply in a disposable unit. The entire unit snaps into the beam holder. It may be changed at any time in an effortless and quick manner.

Conventional pen care techniques may be forgotten. There is no cleaning needed (the pen cannot drool). The pen will stay aloft for days without drying. Should the pen dry, just dampen the tip with water.

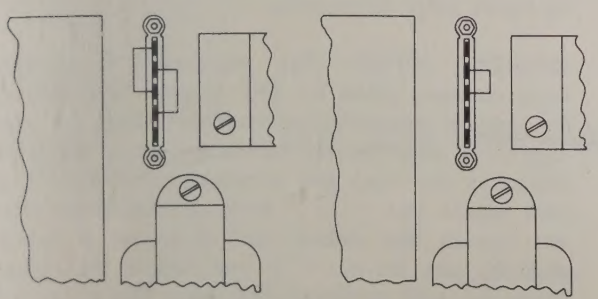
If the pen has been exposed for some weeks and won't write, simply hold it under running water for a minute. Occasionally rub across a paper surface to help it start.

TRACE: The pen was originally set to give a constant trace width over the life of the cartridge. This is a slight compromise of normal recording speeds, pen pressure, cartridge life and trace width. Should the trace skip on high speed recording, turn the screw opposite the cartridge clockwise. Some sacrifice is necessary as the trace will broaden on slower speed signals and the cartridge life may be shortened (see page 16—Pen Pressure).

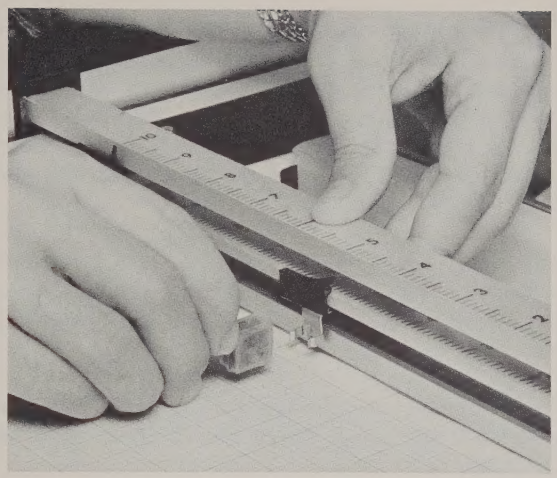
POLARITY: As originally furnished, the recorder has positive polarity, i.e., a positive going signal will drive the pens up scale. There are certain applications where the signal is inverted from the trace presentation desired. Hence, the recorder needs negative polarity or, as the signal goes up, the trace should go down.

This is easily accomplished by simply reversing the phase recognition of the servo system. Follow the procedure for motor/pot access (page 17). Swap leads at the motor. ALSO swap end resistance leads of the rebalance potentiometer.

POWER: Both transformers have dual primaries allowing either 115 or 230 VAC operation over 50 to 60 hz frequency range. A terminal strip located at the intersection of both transformers and vacuum fan bracket, provides jumper tie points for connection in parallel (115 VAC) or series (230 VAC).

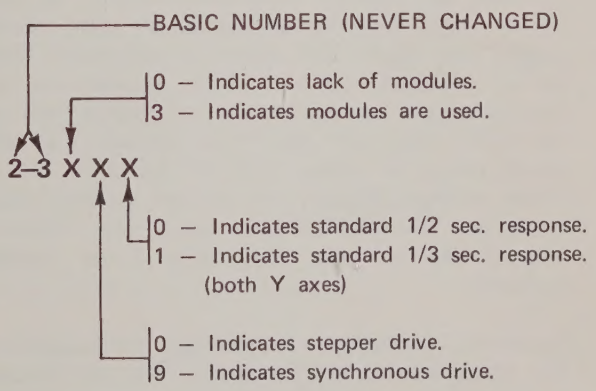


115 VAC **230 VAC**



RACK MOUNTING: The end plates of the recorder may be replaced by optional rack ears. Remove the three screws from one end panel and substitute the rack wing. Now repeat for the opposite side. Installation in the rack is normal procedure.

MODEL NUMBER IDENTIFICATION: The recorder is available with two basically different paper drives — stepper motor and synchronous motor. It can also be furnished with or without modules, and with conventional or high speed response. To distinguish the difference a four digit model number is coded as shown:


BASIC NUMBER (NEVER CHANGED)
0 — Indicates lack of modules.
3 — Indicates modules are used.
2–3 X X X
0 — Indicates standard 1/2 sec. response.
1 — Indicates standard 1/3 sec. response. (both Y axes)
0 — Indicates stepper drive.
9 — Indicates synchronous drive.

This basic model number can be prefixed by "E", which indicates 230 VAC, 50 Hz. operation, or "E1", for 115 VAC, 50 Hz. Suffixes indicate the types of modules supplied. Typically a 2–3301–52–7–7 recorder would be a 115 VAC, 60 Hz. unit (due to lack of prefix), with modules ("3" in second digit), stepper motor driven ("0" in third digit) and have high speed servo ("1" in fourth digit). The suffix "52" indicates the kind of drive module for the chart axis and the "–7–7" illustrates the types of Y axis input modules.

PERFORMANCE CHECKS

The ability of any strip chart recorder to give excellent performance reduces to 6 parameters – gain, calibration, linearity, damping, frequency response and chart time accuracy. All should exhibit stability and tolerance for age and use, and be self-compensating. Theoretically, this would yield the perfect instrument with no need for adjustment.

Practically, the 2–3000 is almost ideal. Five of the parameters meet the perfect criteria. Two adjustments only are needed, and these only when components are replaced.

The following text explains how to check these parameters and what to do should some component let down.

Adjustments can be made from the bottom of the recorder through labeled screwdriver adjustment holes.

Test equipment consists of a low frequency generator (.1 to 10 Hz.) capable of sine, triangle and square wave output, and a 0.05% stable DC source, preferably with decade attenuator.

GAIN: Improper gain setting can cause ragged sloppy traces. Too much gain gives shaky traces and is extremely hard on mechanical portions. Conversely, too little gain results in sluggishness, increased dead zone and a record with poor accuracy.

To check gain, insert a stable signal centering the pen on the chart (or alternately shunt all three inputs together and use the zero control to center pen). With the pen recording, push the pen up or down scale by pressing on the pen bracket on the opposite side of the beam from the pen. When released, the pen should return to within 0.1% of full scale of its original position. Repeat in the opposite direction. Any instability indicates excessive gain. Any opening indicates lack of gain. See Figure 2 for typical examples.

Traditional recorder gain setting calls for adjustment just below the point of oscillation. The performance of the 2–3000 is almost totally independent of gain due to the electronic dead band detector. Optimum gain is achieved by placing the gain pot in mid-position. Actually, anywhere from 20 to 80% of the pot range will suffice.

CALIBRATION: To check, use a precision source (0.05%) with a sufficient range to cover the recorder's sensitivity. With the source connected and at a minimum value set pen zero to coincide with the chart margin. Now set the source for full scale sensitivity, which should coincide with the paper full scale grid. Adjust the calibration control only if not correct. The following page shows a somewhat extended procedure which also checks for linearity.

LINEARITY: The expanded procedure for calibration is the most expedient check. Another method is the use of the sweep generator (but only if conformity is better than 0.05%). Set the generator on a triangle output with a sweep somewhat greater than the chart width. Frequency should be approximately 0.1 Hz. Set the chart drive at 20 inches per minute. Actuate the pen as the ramp starts up. Raise pen at full scale. The resulting trace should vary no more than 0.1% of full scale (Figure 1. This procedure is dependent on stability of the line frequency and conformity of the sweep generator and is not generally recommended.

DAMPING: There is no adjustment, as this was fixed when shipped. For check, use a square wave output with an amplitude of approximately 1/3 scale. Set the square wave at 0.1 Hz. initially, with a chart sweep speed of 10 inch/minute. Increase square wave frequency to 5 Hz. and concurrently decrease amplitude to 1 inch maximum. (See Figure 4.) There should be less than 1% overshoot at any frequency. If not, check lead network R-8 and C-6 of the servo amplifier for proper values or defective components.

FREQUENCY RESPONSE: With the chart moving at 10 in/min., apply a 1 inch peak to peak sine wave of 1 Hz. Increase frequency slowly to 3 Hz. Amplitude should decrease approximately 10%. (See Figure 5). NOTE: Attenuation is 3 db/octave above 2 Hz. in preamplifier modules.

CHART TIME ACCURACY: Using the recording pen or event marker, make a mark on the chart. Now start the chart moving for a fixed period of time. Stop and make another mark – scale for correctness. Should any error exist check line frequency stability. As with any line frequency based system, there can be short term variations which are usually corrected on a cumulative basis by the power company. Should the variance not coincide with the line frequency fluxions, check for mechanical binding in the mechanism; then to circuit faulty components.

CURRENT OFFSET: This adjustment is probably never necessary unless the FET choppers are replaced. Set module sensitivity to maximum. Use the zero control to place the pen approximately at mid scale. Disconnect any input and substitute a shunting 100 K ohm resistor from + to – terminals. Alternately short and connect this resistor with a jumper or switch observing pen movement. If any, adjust the current offset pot until movement disappears. This adjustment not necessary when ACTIVE preamplifier modules (Types 7, 8, 11 etc.) are used, as these modules have their own current offset adjustments.

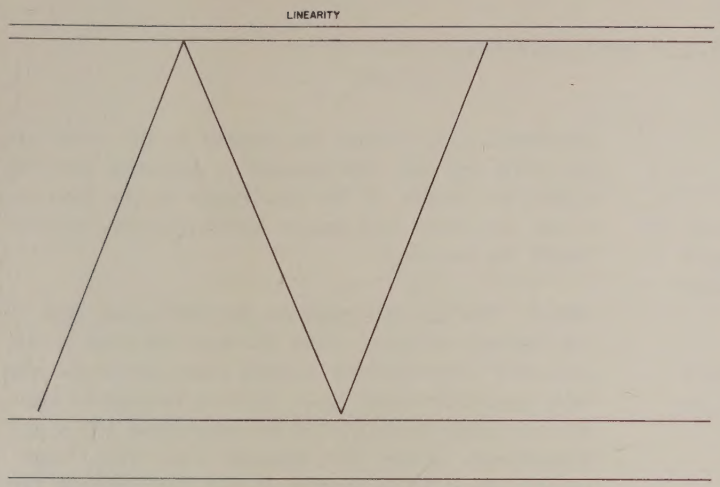


FIGURE 1

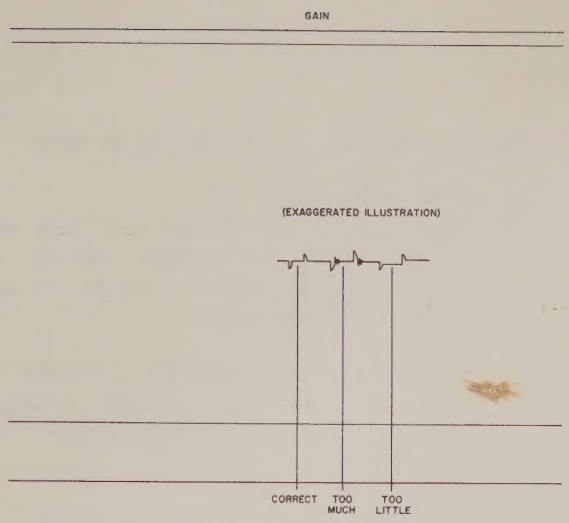


FIGURE 2

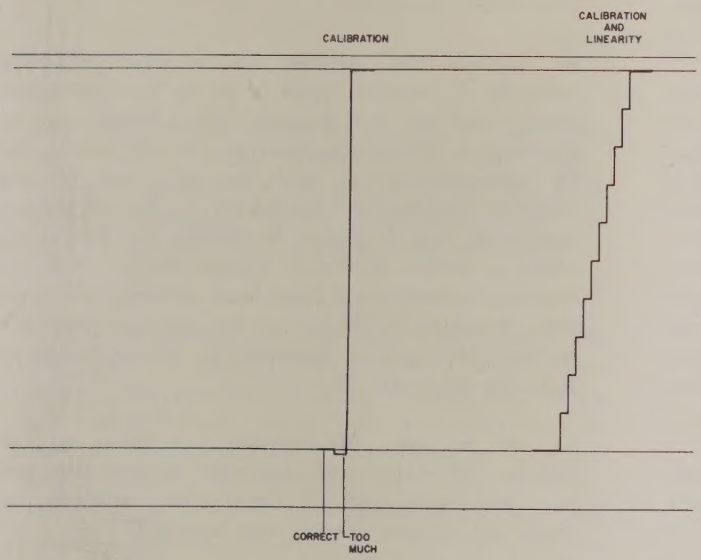


FIGURE 3

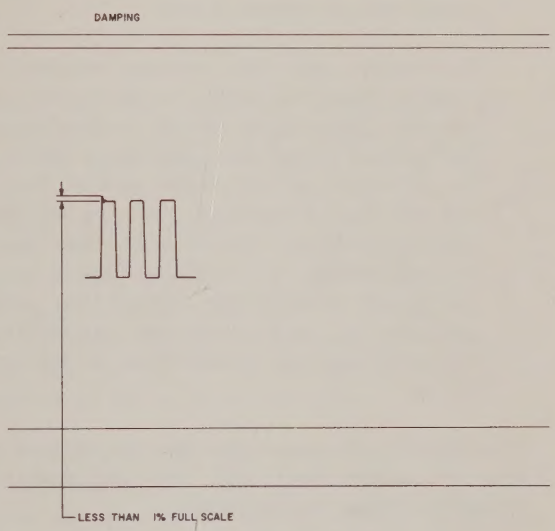


FIGURE 4

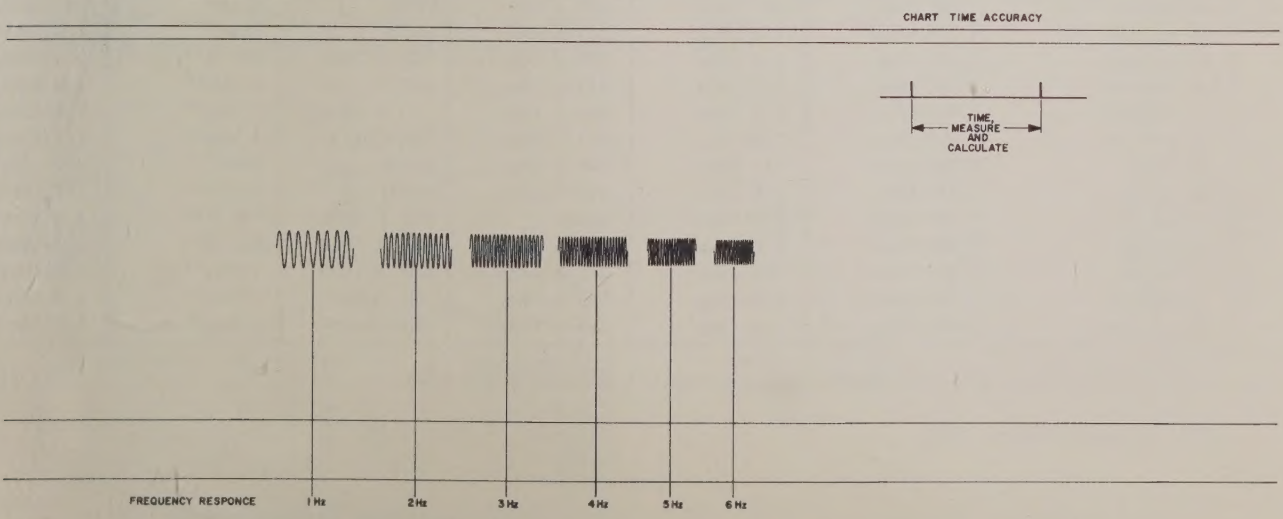


FIGURE 5

DEDICATED APPLICATION

There are two ways the recorder can be used:

1. WITH MODULES:
   These modules allow manual front panel control of chart speed, event marker, pen lift, signal scaling, zero, etc. Separate modules are supplied for chart and input axes.

   IF MODULES ARE USED NO FURTHER TEXT NEED BE READ as individual modules are described in Section Two of this manual.

2. WITHOUT MODULES:
   Predominant use is for dedicated applications or where the operator should be restricted. The recorder is supplied as a bare mainframe only — having no manual controls. Yet the unit is fully operational by remote control.

   To achieve this use without modules, three terminal boxes are added to the bottom of the recorder. These boxes vary in function depending on position — yet each provides a barrier strip for connection of the remote control. They serve the additional function of preserving the integrity of the mainframe. This allows the later expansion of the recorder to traditional module operation by simply replacing the terminal box with the modules. In other words any customizing for dedicated operation is performed in the terminal boxes.

The following information describes the different types, how to custom your unit, and the general wide flexibility inherent to the design.

CONTROL: The smaller box located in the center of the three has only one function — providing terminal points for control of the pen. Power to the recorder is not controlled as a system switch normally is used before the line cord.

INPUT: This box is located on the right under side of the recorder as viewed from the top. Referring to the schematic, two terminals provide input points for the fixed sensitivity input signal. A third terminal is earth ground. Origin control is via the screwdriver adjust pot incorporated within the terminal box. This "zero" control allows initial setting — it is not intended for continuous correction. The three spare terminals can be used for external zero control by running shielded wire to a 2K pot (the internal pot must be disconnected as shown).

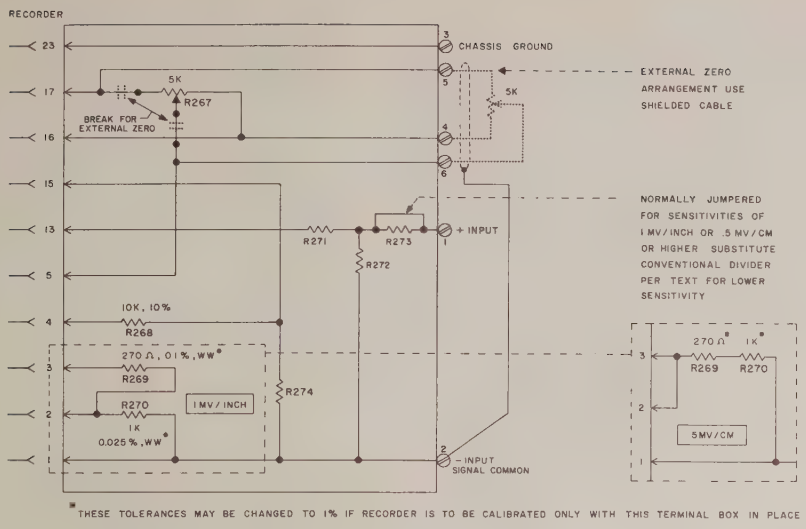
As supplied, the recorder has a fixed sensitivity (normally 1 mv/inch) which is set by two calibration resistors and two gain resistors. The sensitivity may be increased by changing resistors as indicated below. Use 1% deposited carbon; trim the adjustment by the amplifier CALibration adjustment (±7% adjustment range) per page 6. Lower sensitivities can be set by adding a divider as shown. Typical divider values are illustrated which give a fixed total resistance of 1 meg ohm. Maximum sensitivity can be no higher than 0.4 mv/inch. Minimum is restricted to the equivalent of 500 volts full scale.

As can be seen, the terminal box serves a dual function; (1), component placement for gain loop and zero adjustment, and (2), connection terminals for input, and optional external zero control.

SENSITIVITY (Typical)	R-269	R-270	R-271	R-272	R-273	R-274
0.4 mv/inch	866 Ohm	402 Ohm	249 K Ohm	OPEN	Shunt*	390 Ohm
1.0 mv/inch	270 Ohm	1 K Ohm	249 K Ohm	OPEN	Shunt*	1 K Ohm
10 mv/inch	270 Ohm	1 K Ohm	158 K Ohm	100 K Ohm	900 K**	1 K Ohm
100 mv/inch	270 Ohm	1 K Ohm	243 K Ohm	10.1 K Ohm	1 Meg**	1 K Ohm
1 volt/inch	270 Ohm	1 K Ohm	249 K Ohm	1 K Ohm	1 Meg**	1 K Ohm
10 volt/inch	270 Ohm	1 K Ohm	249 K Ohm	100 Ohm	1 Meg**	1 K Ohm
0.2 mv/cm	768 Ohm	511 Ohm	249 K Ohm	OPEN	Shunt*	390 Ohm
0.5 mv/cm	270 Ohm	1 K Ohm	249 K Ohm	OPEN	Shunt*	1 K Ohm
1.0 mv/cm	270 Ohm	1 K Ohm	Shunt	499 K Ohm	499 K**	1 K Ohm
10 mv/cm	270 Ohm	1 K Ohm	200 K Ohm	49.9 K Ohm	953 K**	1 K Ohm
100 mv/cm	270 Ohm	1 K Ohm	249 K Ohm	4.99 K Ohm	1 Meg**	1 K Ohm
1 volt/cm	270 Ohm	1 K Ohm	249 K Ohm	499 Ohm	1 Meg**	1 K Ohm
10 volt/cm	270 Ohm	1 K Ohm	249 K Ohm	49.9 Ohm	1 Meg**	1 K Ohm

* Potentiometric input. If a lower input resistance is desired, R-272 may be any value.

** 1 meg input resistance ±2%.



INPUT TERMINAL BOX

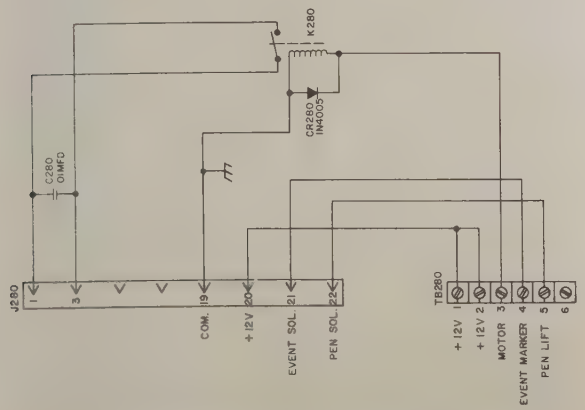
CHART DRIVE

Two types of chart drives are available in this series. Units having 2–3000 model numbers use stepper motors. Units with model numbers 2–3090 use fixed speed synchronous motors. Terminal boxes are different for each type, although both are located on the left side.

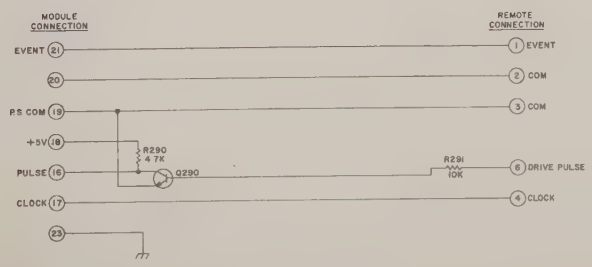
For the synchronous unit terminals 1 or 2 and 3 give control of the motor via an external isolated contact closure. Also incorporated in the terminal box are the pen lift and event marker terminals, which can be operated simultaneously with chart advance. These use contact closure, with terminals 1 or 2 and 5 for pen lift and 1 or 2 and 4 for event marker via individual contact closures. (Note that the pen lift is supplementary to that of the center control described in the prior section.)

The stepper units require an external pulse source when used without complete modules. Effectively the recorder has drive circuits and a stable clock, but no manipulation ability. External dividers may be used from the clock source (Terminal 4) and fed into Terminal 6. Or the pulse can be from a pulse generator, contact closure, etc. The recorder mainframe includes a buffered input to the drive circuitry to accept a wide latitude of sources of greater than 5 volt positive going pulses into a 10 K ohm load. Maximum pulse rate is 200 per second. The reference clock signal is 120 or 100 Hz. depending on the line frequency of 60 or 50 hz respectively.

Each pulse drives the chart 1/360 of an inch for 60 Hz. units or 1/300 of an inch for 50 Hz. units. The source can be highly accurate, linear, nonlinear or according to application. The event marker can be used in conjunction with scale by giving timing marks. Or the pulse train can be a function of a variable rather than time (turn of a shaft, position, count, etc.).



SYNCHRONOUS TERMINAL BOX



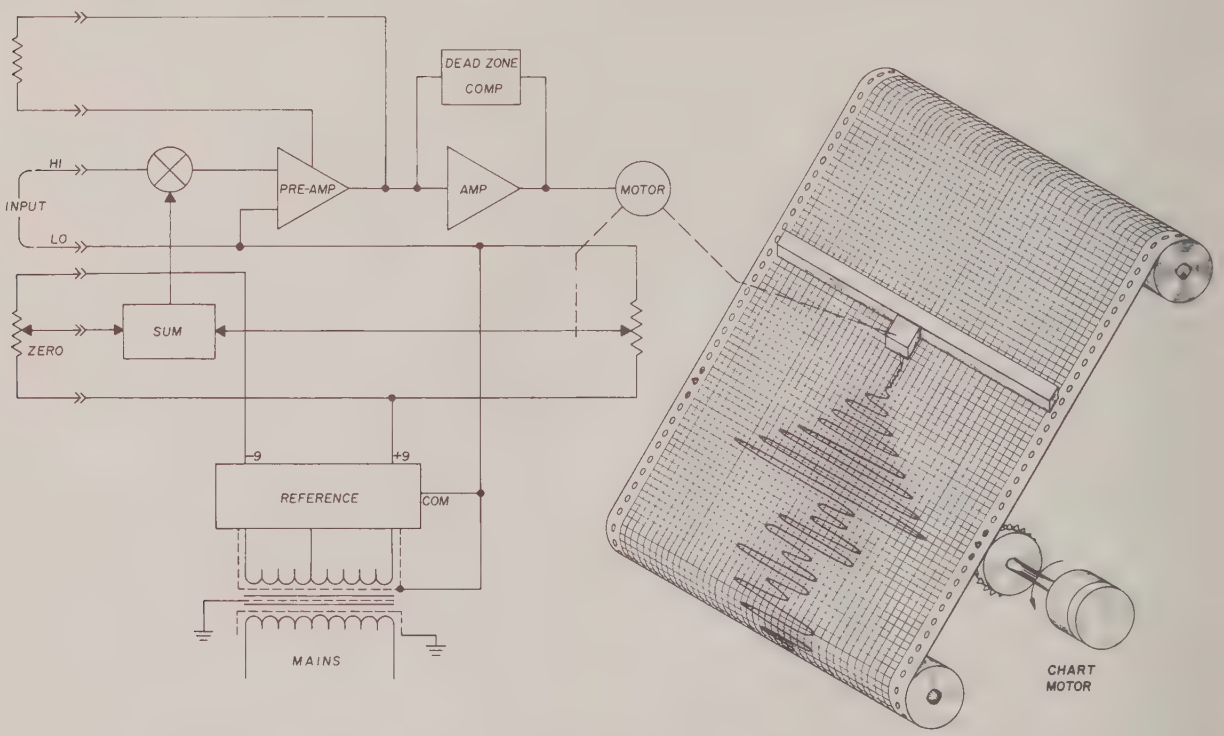
STEPPER TERMINAL BOX

GENERAL CIRCUIT DESCRIPTION

In broad principle a conventional potentiometric servo is used. The input signal is compared at a solid state chopper against the voltage sum of the rebalance and zero potentiometers. Any difference in voltage or polarity causes the amplifiers to direct properly phased currents to the servo motor. This drives in the correct direction to balance the servo loop via the feedback from the rebalance pot to the summing junction. Concurrently, the mechanically linked pen draws a trace directly proportional to the varying input signal.

Several unique features are applied to produce a modern servo. Dead band compensation is incorporated in the amplifier, which reduces "jitter" in the loop without a reduction in overall gain. Effectively this eliminates the traditional critical gain setting adjustment. The reference supply is fed by a triple shielded transformer with the secondary shield tied to the low input side. This coupled with acute double isolation of all components and wiring, yields outstanding common mode rejection.

The chart drive can be either a synchronous single speed motor or a stepper motor. The synchronous motor is driven directly from the line power with a rate directly proportional to the line frequency. Conversely the stepper motor instruments are driven directly from a series of quadrature pulses. These pulses are generated within the recorder mainframe and are stimulated by a line reference clock.



DETAILED DESCRIPTION: The input signal from the module is applied to Pin 22 on the amplifier connector, through R1 to a MOSFET integrated circuit chopper, IC1. The rebalance feedback signal is applied to the chopper via Pin 16. This feedback signal originates at the rebalance potentiometer (driven mechanically by the servo system), and prior to scaling appears at Pin 10. A divider network composed of R4 through R9 attenuates the rebalance signal to a level of 1 mv change for each 1 inch (or 2 cm) increment of pen movement. The output of this divider appears at Pin 15, and is further divided and loaded by two external resistors. English calibration (1 mv/in) is obtained by connecting Pin 16 to point A; metric calibration (0.5 mv/cm) is obtained by connecting Pin 16 to point B. Pin 11 is connected to a junction (point C) higher in the divider string, and is used for external variable attenuation. Capacitor C6 provides electrical damping of the servo response. Resistor R5 is the summing resistor for the Zero potentiometer.

The input and rebalance signals are compared and modulated by IC1 producing a square wave output (the servo error signal) which appears at Pin 1 of the chopper. This signal is coupled through R2 and C5 to FET Q1. Q1 and Q2 form a differential input amplifier stage for a preamplifier composed of C4, C5, C7 – C13, CR1, CR2, R2, R3, R10 – R22, Q1, Q2,

Q3 and an integrated circuit operational amplifier, IC2.

The output of this preamplifier appears at Pin 6 of IC2, and is fed back to the gate of Q2 by two paths. D.C. stabilization is provided by the path through R17 and R16, but the A.C. component of the feedback signal is removed by C8. The A.C. gain is controlled by the other path which travels through an external divider via Pins 6 (point E) and 13 (point F) and then through R15 — C7 to Q2. The gain is determined approximately by the product of the ratios of the external divider and the A.C. divider formed by R15 — R16. The external divider provides external gain control which is required for various control functions in the input modules.

Transistor Q3, R18 — R20 are a current source for proper biasing of the differential input pair, Q1 and Q2.

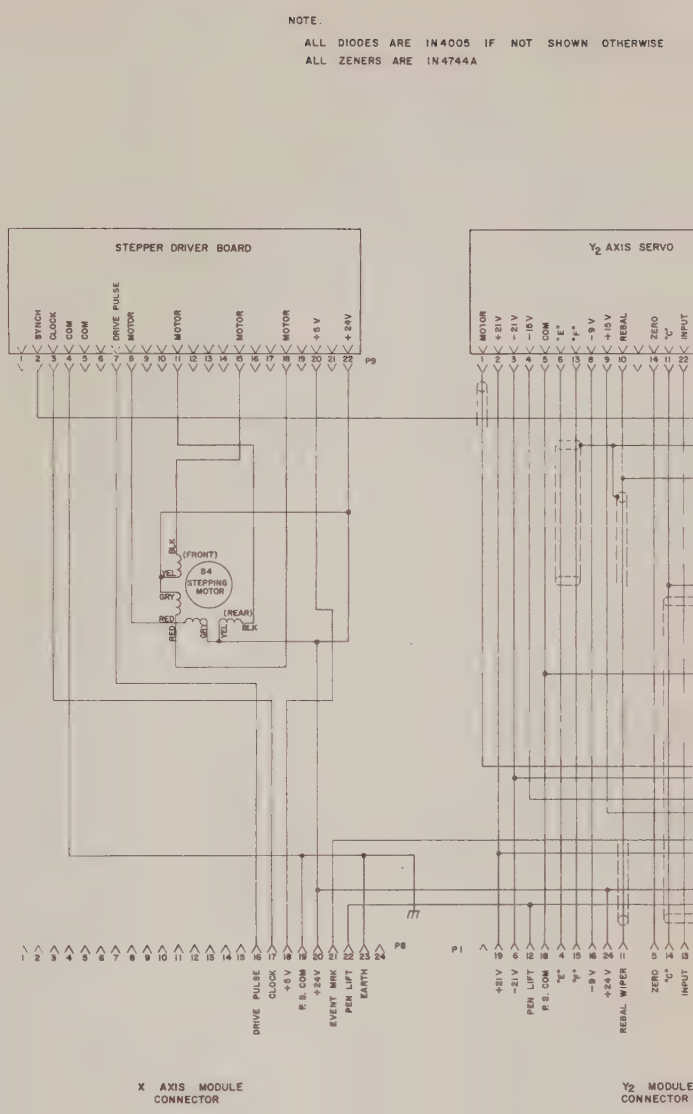
The output of the preamplifier passes through C12 and the internal gain control, R25 to the input of a full wave demodulator composed of R26, R27, R29, R30, Q4 and Q5. The gates of Q4 and Q5 are driven synchronously with the chopper, IC1, in such a way that alternately Q4 and then Q5 become short circuits to the amplified error signal. This yields two signals, each displaying only one-half of each cycle of error signal. These two outputs are summed algebraically and amplified by the differential amplifier, IC3. The result is a full wave demodulated representation of the error signal, which is a D.C. signal.

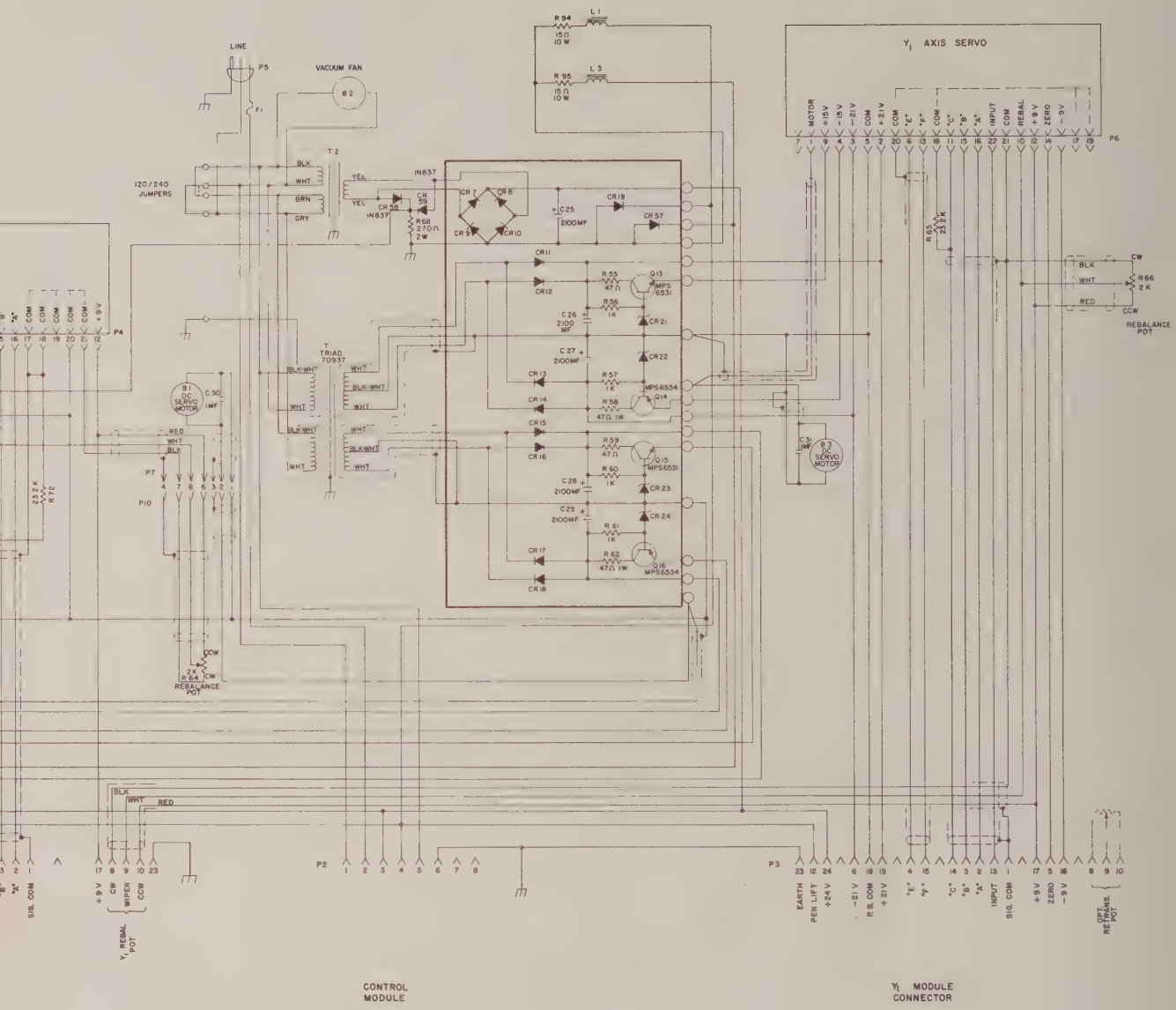
The new D.C. error signal power level is buffered by a complementary, two stage Darlington configuration composed of Q6 — Q9 and associated resistors. The available output current is intentionally limited by collector resistors R38, R39, R42 and R43. The resistors R40 and R41 provide reverse bias for Q7 and Q9 to insure that these two transistors never conduct current simultaneously.

The output of the power stage is applied directly to the servo motor and to a non-linear feedback network composed of R36, R33, R29 and R30 (part of the demodulator), C20, C21 and zener diodes, CR5 and CR6. The purpose of this network is (1), to control the gain of the amplifier — demodulator section so that no part of the total servo is operating "open-loop" or without feedback stabilization of temperature, voltage and aging effects and (2), to provide the "dead zone compensation" mentioned in the general description. The transfer characteristics of this network are such that the incremental gain of the servo amplifier is highest at null, and therefore static errors due to dead zone are reduced or eliminated.

A power protection circuit is provided to limit dissipation in the servo motor. This circuit is composed of Q17, Q18, CR20, CR25, CR26, CR27, R37, R39, R43, R69, R70, and R71. The purpose of this circuit is to reduce the voltage applied to the servo motor after the system has been driven against the mechanical stops or limits for more than a few seconds.

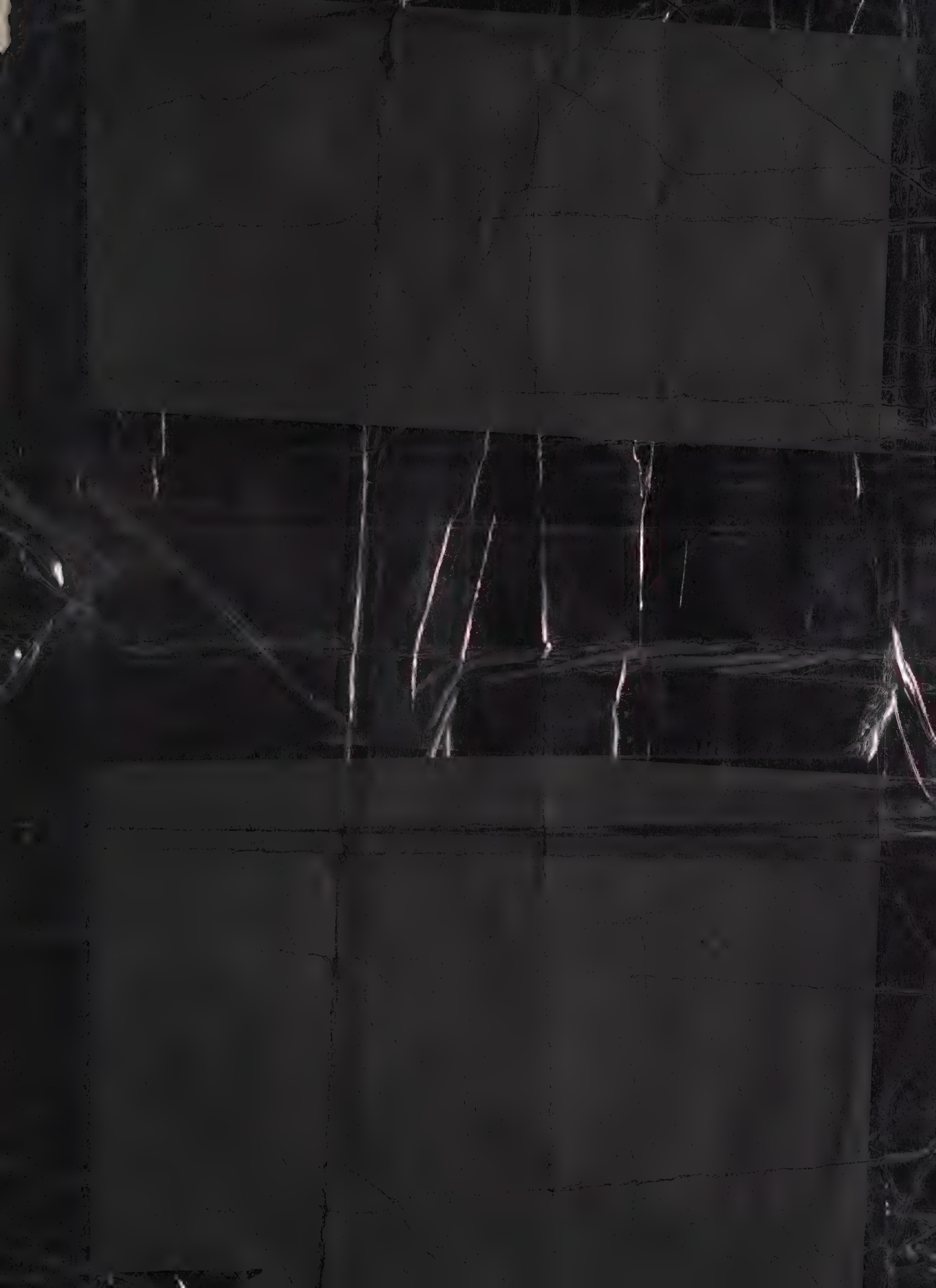
The circuit can be divided into two complementary sections corresponding to positive and negative voltage limiting. The positive section will be described to illustrate the circuit operation. With zero volts present at the output of IC3 (and therefore zero volts at the

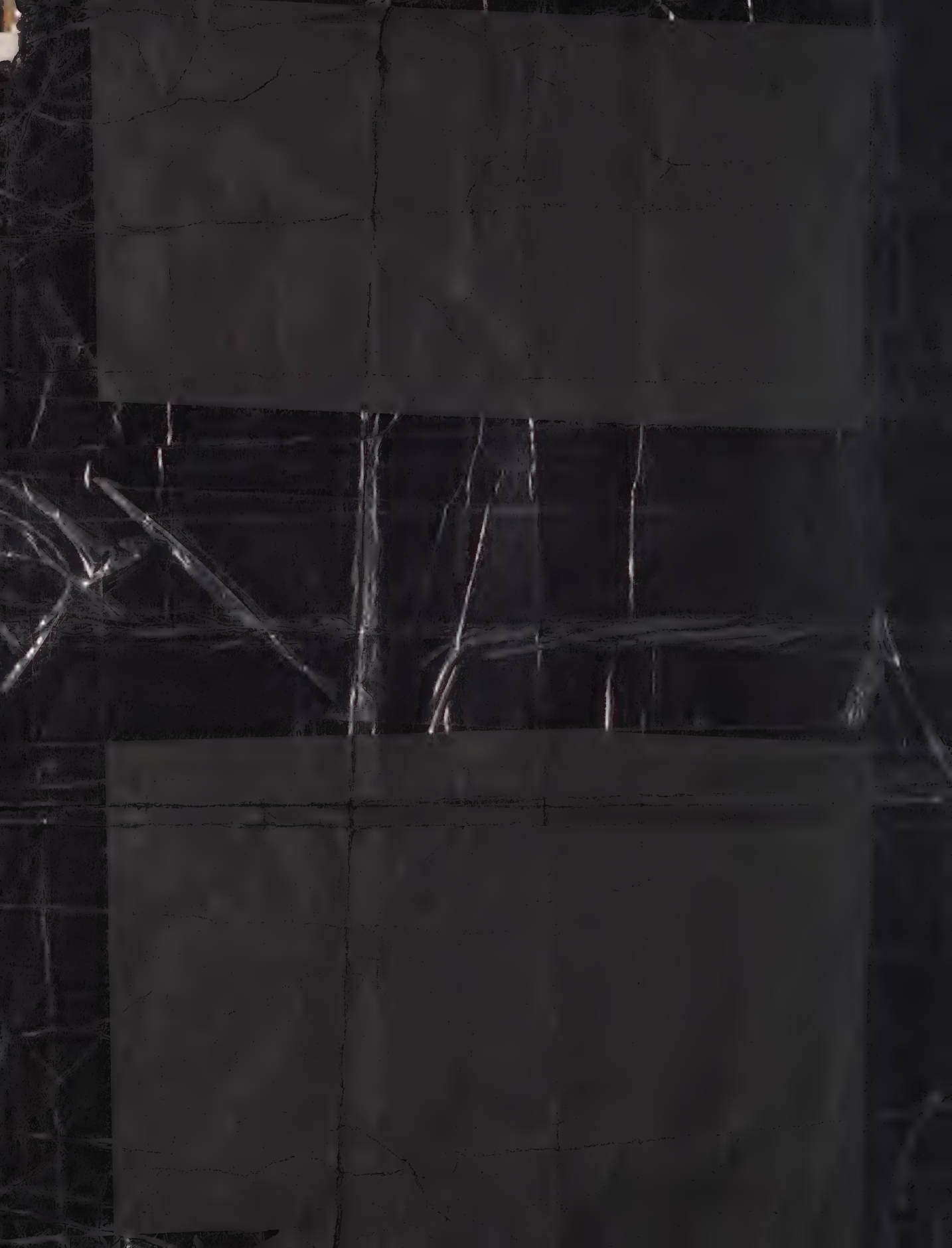


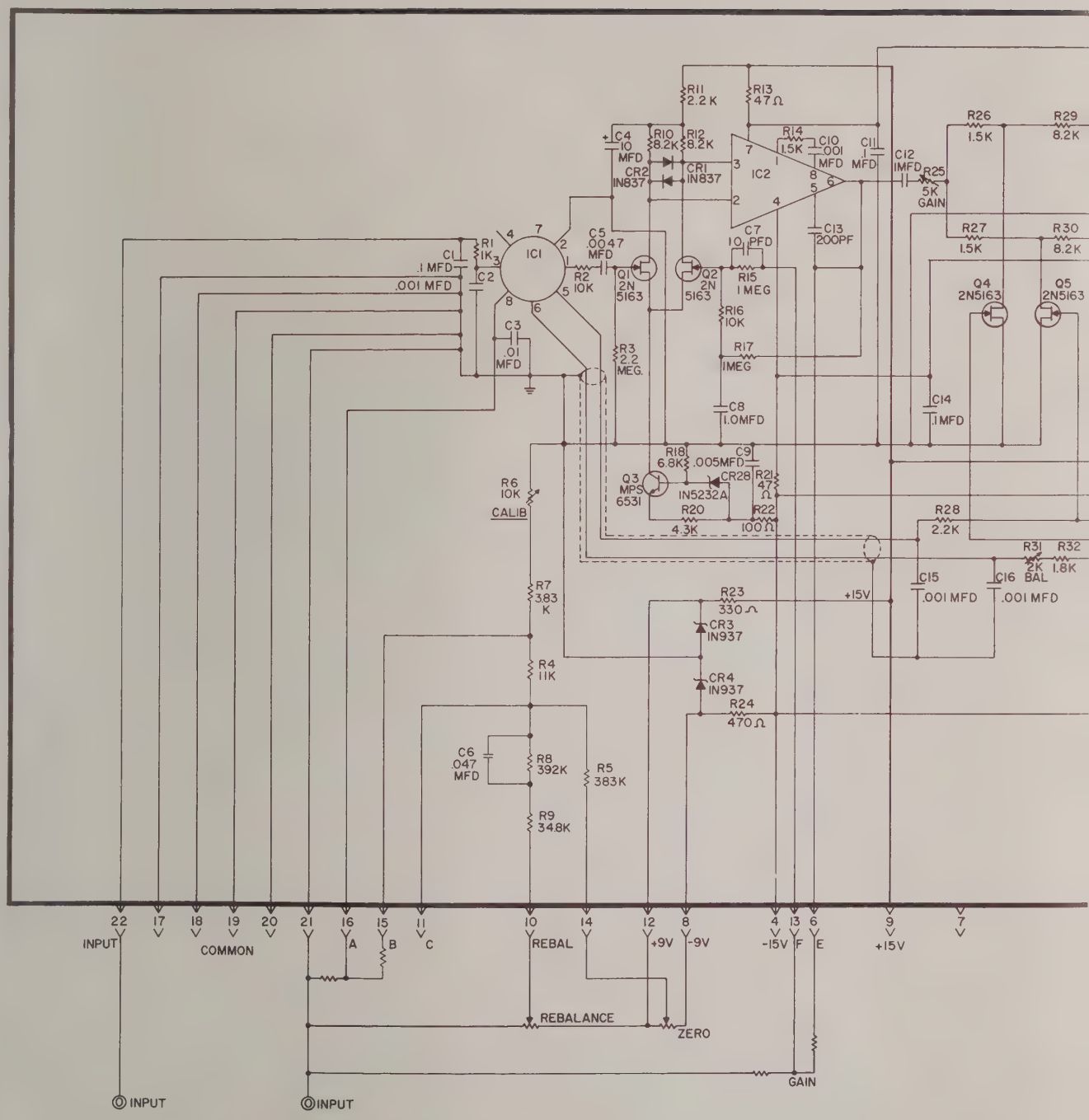


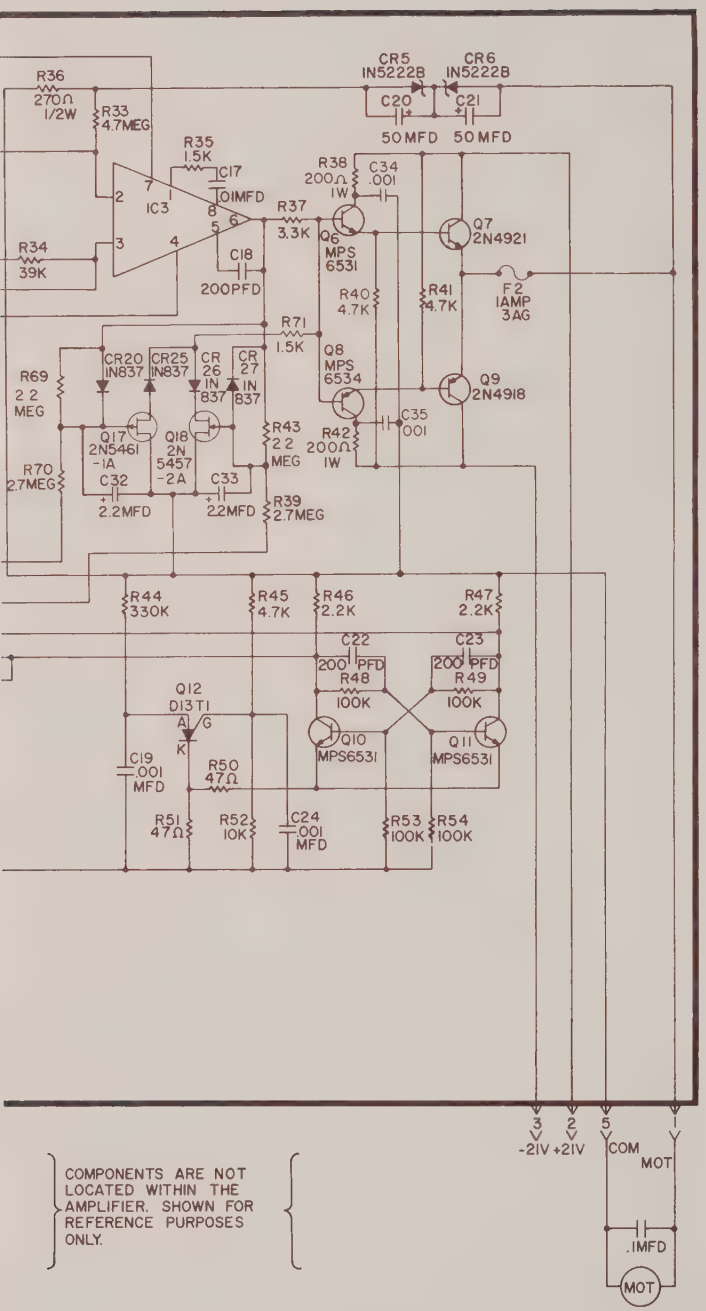
motor), the gate of Q18 is biased negative to cutoff by divider R39 – R43. This means that Q18 is an open circuit with no drain current flowing. As the output of the amplifier swings to a preset positive level, Q18 begins to conduct through CR26, R37 and R71, dropping the output follower amplifier. C33 delays the rise of the gate voltage to keep Q18 open during normal slewing of the servo. Note, however, that C33 discharges rapidly through CR27 upon reversal of the output voltage. This feature allows instantaneous response to a reversing input signal which brings the pen off the mechanical limits. Thus no degradation of performance is generated by this circuit. Q17 functions in the same manner for negative output voltage.

The chopper and demodulator are driven by an oscillator-drive circuit composed of Q10, Q11, Q12 and associated components. Q12 is a programmable unijunction transistor and is the heart of a relaxation






R11 2.2 K
R13 47Ω
R26 1.5K
R29 8.2K
C4 10 MFD
R10 8.2K
R12 8.2K
R14 1.5K
C10 .001 MFD
C11 1 MFD
C12 1MFD
R25 5K GAIN
CR2 IN837
CR1 IN837
IC2
R27 1.5K
R30 8.2K
C1 .1 MFD
.001 MFD
C2
IC1
C5 .0047 MFD
C7 10 PFD
C13 200PF
R1 1K
R2 10K
Q1 2N 5163
Q2 2N 5163
R15 1 MEG
Q4 2N5163
Q5 2N5163
R16 10K
C3 .01 MFD
R3 2.2 MEG.
R17 1MEG
C14 .1MFD
C8 1.0MFD
R18 6.8K
C9 .005MFD
R21 47Ω
CR28 IN5232A
Q3 MPS 6531
R6 10K CALIB
R20 4.3K
R22 100Ω
R28 2.2K
R31 2K BAL
R32 1.8K
C15 .001 MFD
C16 .001 MFD
R7 383 K
R23 330Ω
+15V
CR3 IN937
R4 11K
CR4 IN937
R24 470Ω
C6 .047 MFD
R8 392K
R5 383K
R9 34.8K
22 INPUT
17
18 COMMON
19
20
21
16 A
15 B
11 C
10 REBAL
14
12 +9V
8 -9V
4 -15V
13 F
6 E
9 +15V
7
REBALANCE
ZERO
GAIN
INPUT
INPUT



oscillator. The frequency of oscillation (approximately 1 K Hz) is determined by the time constant R44 – C19 and the divider R45 – R52. The output pulse of the oscillator emitter couples to a bi-stable flip-flop through R50. The flip-flop (Q10, Q11, etc) provides two perfectly symmetrical outputs which are coupled directly to the demodulator, and to the chopper through two R–C lag networks, R28 – C15 and R31 – R32 – C16. The latter network is adjusted to cancel nonsymmetry in the chopper and thus eliminates offset currents at the input.

The reference supplies for the rebalance and zero voltages are derived from CR3 and CR4, which are highly stable temperature compensated zener diodes. The operating current for these supplies is supplied by the 15 volt supply located on the power supply board.

The main frame contains three independent power supply systems. Power for the Pen Lift and Event solenoids is provided by the supply composed of transformer T2, CR7 – CR10 and C25. This is a conventional full-wave, bridge rectified supply with capacitance input filter. Diode CR20 is a clamp to shunt the inductive voltage spike generated when the solenoids are de-energized.

The servo system is powered by one of the two separate shielded secondaries of a high quality isolation transformer, T1. This transformer has solid shields enclosing each primary and secondary winding so that the effective capacitive coupling between each winding is less than 0.1 picofarad ($< 10^{-13}$ farad). This insures that negligible amounts of line frequency common mode voltage or current will be generated within the recorder itself, and allows the system to be used in a floating or differential mode. THIS IS AN IMPORTANT CONSIDERATION, AS MOST RECORDERS INCLUDE A LARGE CAPACITOR (TYPICALLY 0.1 TO 1 MFD) FROM THE "LOW" SIDE OF THE INPUT CONNECTOR TO CHASSIS OR EARTH GROUND FOR THE EXPRESS PURPOSE OF SHUNTING THE INTERNAL LINE FREQUENCY CURRENTS TO GROUND. Obviously such a system is not even a good approximation of being differential. No such shunting device is needed or incorporated in the 2–3000 recorder.

The D.C. portions of these supplies are conventional full wave, center tapped supplies with capacitance input filters, and zener reference series regulators for the plus and minus 15 VDC rails. No regulation is needed for the plus or minus 21 VDC supplies. The primaries of both T1 and T2 may be wired for either 120 of 240 VAC operation.

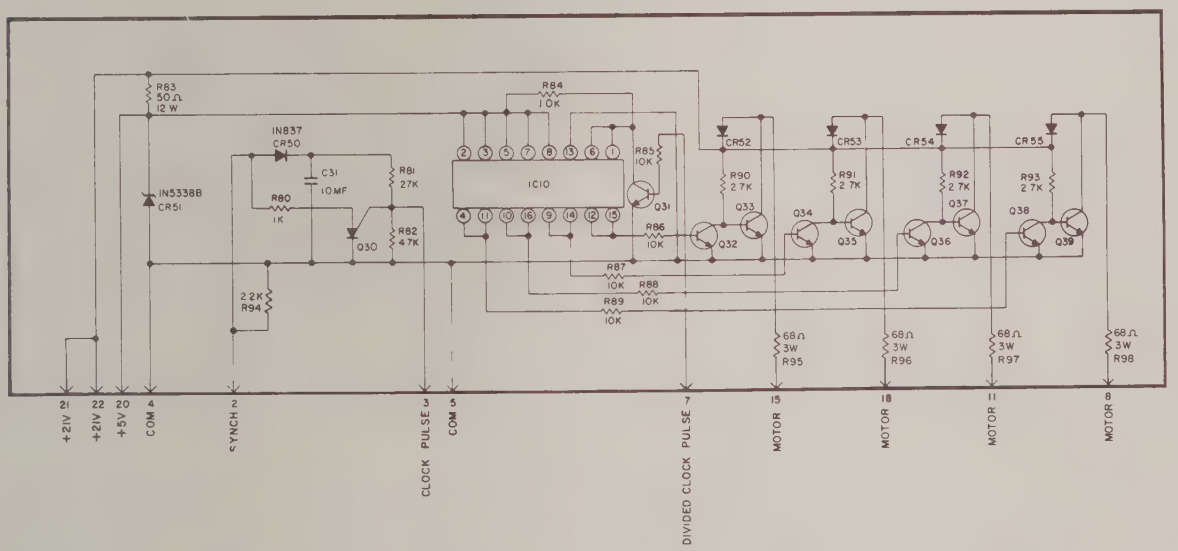
The third power supply uses the other secondary of T1 with CR1 and 2 to produce raw unregulated +21 volt. CR3 and 4 provide the basic line synchronous

source. The output of this source is a full wave rectified sine wave which yields 100 pulses per second for a 50 hz line and 120 pulses per second for a 60 hz line.

This output pulse string is applied to the stepper driver board through Pin 2 and on to the input of a latching threshold detector composed of R80, R81, R82, CR50, C31 and Q30 (a programmable unijunction transistor). CR50 and C31 form a peak voltage storing rectifier which in conjunction with R81 and R82 develop the threshold level (or "trip level) of the circuit. When the instantaneous voltage at R80 exceeds the output voltage of the divider (R81 – R82), then Q30 latches, pulling the output of the divider to zero volts. The output voltage swing is approximately 5 volts. Q30 remains latched until the input voltage returns to near zero volts, thus protecting against multiple triggering during each half cycle of line voltage.

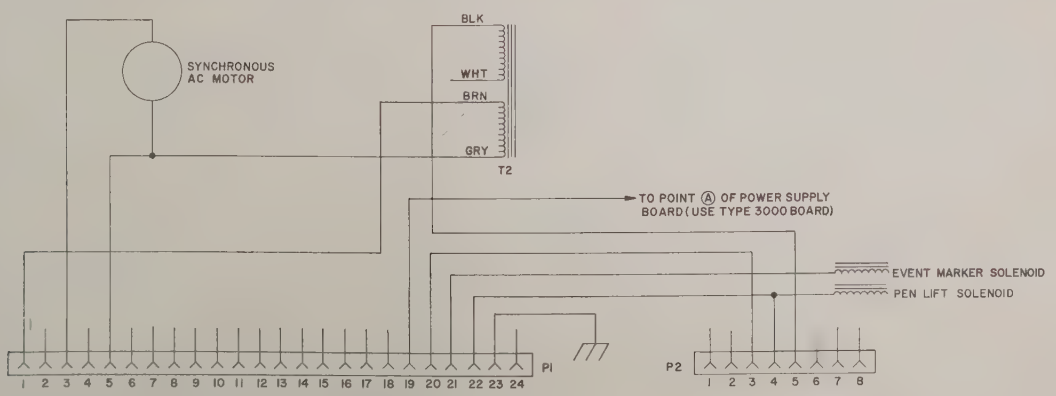
The clock pulse exits the board on Pin 3 and is carried to the stepper control module. This module divides the pulse rate to the desired value and returns the new pulse to the driver board through Pin 7. The pulse is buffered by Q31 and R84 and applied to Pins 1 and 6 of IC10, a dual J–K flip-flop package. These two flip-flops are connected in a parallel counter configuration which generates a standard, four phase sequence for driving the stepper motor. The four outputs of the flip-flops are applied to four identical driver circuits composed of R86, Q32, R90, Q33, CR52 and R87, Q34, R91, Q35, CR53, etc. The diodes clamp the collector voltages to protect the output transistor from damage due to inductive spikes from the motor.

STEPPER DRIVER BOARD



EXCEPTION FOR 2–3090 & 2–3390 SYNCHRONOUS UNITS

Since this is a very simple unit, it is not shown in detail. The mainframe schematic applies exactly as concerned with input and power controls. However the chart drive circuitry is covered by the following:


SYNCHRONOUS AC MOTOR
BLK
WHT
BRN
GRY
T2
TO POINT Ⓐ OF POWER SUPPLY BOARD (USE TYPE 3000 BOARD)
EVENT MARKER SOLENOID
PEN LIFT SOLENOID
P1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
P2
1 2 3 4 5 6 7 8

TYPE 53 MODULE

POWER MODULE

TROUBLE SHOOTING

Before attempting to trouble shoot the recorder, make certain that the trouble is not caused by improper module control settings. Check to see that input signals are being received and that the signals are proper with no unusual noise. Check to make sure that there is power at the mains.

SYMPTOM	TROUBLE	REMEDY
1. Pen won't write or skips.	a. Cartridge tip is dried or out of ink.	a. Wet — See page 5 or replace.
	b. Insufficient pressure.	b. Adjust — See page 5 and 16.
	c. Improper lift spacing.	c. Check lift mech. See page 16.
2. Trace is too broad.	a. Excessive pen pressure.	a. Adjust — See page 5.
3. Pen–up Down inoperative	a. Faulty solenoid.	a. Check continuity.
	b. Power supply.	b. Check for +15v at L-1.
	c. Binding of mechanism.	c. Check for contaminants and freedom of movement.
	d. Faulty switching.	d. Check switch or remote activation.
4. Event Marker inoperative	a. See 3.	a. See 3.
5. Calibration incorrect	a. Vernier switch in VAR.	a. Place in CAL.
	b. Calibration adjustment incorrect.	b. Re-adjust. See page 6.
	c. Faulty reference supply.	c. Check for +9v and –9v at connector.
6. Recorder dead	a. Check main fuse.	a. Replace once, if it blows again, find fault in power supply.
	b. Faulty power supply.	b. Check entire power supply, including transformer.
7. Y axis dead	a. Bad component in module.	a. Check for signal to mainframe; if not, find troubled component; if apparent, go to b.
	b. Bad component in amplifier	b. Check for output; if none find bad component; if apparent, go to c.
	c. Bad motor.	c. Replace.
8. Y drives to zero or full scale.	a. Attenuator and zero setting incorrect.	a. Turn attenuator to coarsest setting and rotate zero to see if balance can be achieved.
	b. Open rebalance pot.	b. Replace.
	c. Reference voltage faulty.	c. Check for low voltage across pot. Should be 9v ±5%.
	d. Bad amplifier component.	d. Find fault.
	e. Phase reversal of motor or rebalance pot during repair.	e. Reverse any two of the leads misplaced during repair.

SYMPTOM	TROUBLE	REMEDY
9. Y drifts to zero or full scale.	a. Open input.	a. Shunt input.
	b. Open rebalance pot.	b. Replace.
	c. Defective amplifier.	c. Find default.
	d. Open zero.	d. Replace.
10. Jitter (at all points of trace).	a. Open signal input.	a. Either shunt input or turn off recorder.
	b. Noisy signal source or wiring.	b. Disconnect input and shunt. If jitter disappears, fix source.
	c. Gain too high.	c. Adjust per page 6.
	d. Noisy rebalance potentiometer or component.	d. Check pot, then amplifier.
	e. Noisy zero pot.	e. Replace.
11. Jitter (at one point only).	a. Bad place in rebalance pot.	a. Replace.
12. Excessive dead zone.	a. Amplifier gain too low.	a. Adjust. See page 6.
	b. Mechanism dirty.	b. Clean.
	c. Contaminants in motor/pot gear train.	c. Clean.
	e. Faulty amplifier component.	e. Find fault.
13. Jerky movement	a. See 12.	a. See 12.
14. Erratic performance in Y axis.	a. Excessive line voltage variation.	a. Use constant voltage transformer.
	b. Rebalance pot has internal contaminant.	b. Run using repetitive low frequency. Contaminant will either clear or pot must be replaced.
15. Sluggish Y axis.	a. See 12.	a. See 12.
16. Chart drive dead.	a. Check power supply.	a. Check for bad component.
	b. Faulty motor.	b. Check continuity.
17. Paper rides over sprocket teeth.	a. Slip clutch too tight.	a. Set per page 17.
18. Paper tears at sprocket.	a. Binding of paper feed roll.	a. Find bind point.
	b. Electrostatic charge on paper.	b. Spray plastic surface with Anti-static spray.

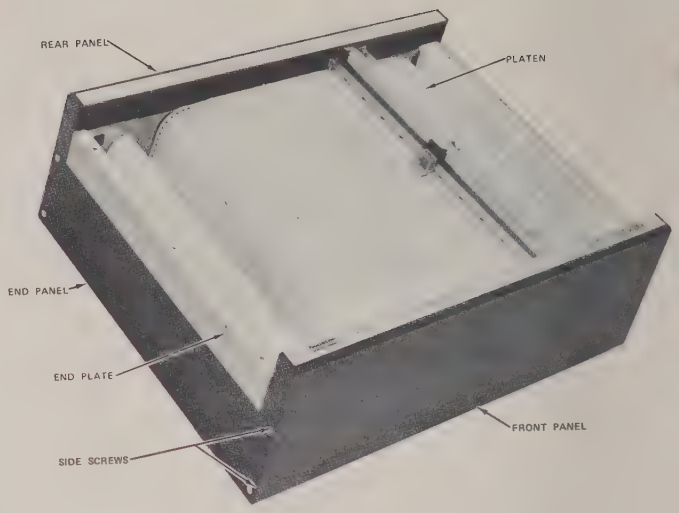
ACCESS: Three portions of the recorder can be individually exposed with minimum effort.

BOTTOM: Amplifier, power supply, main wiring, chart motor, servo motor/potentiometer and connectors are totally exposed by removing the bottom plate held by the four rubber feet. (For those units with modules, the procedure is the same as modules are attached to the bottom plate and pull away from the mainframe.)

SIDES: All cabling, drive pulley and chart linkage are exposed by removing side screws at each end of the front or rear panel.

The amplifier may be removed as an entire assembly by detaching the two flange screws and pulling the entire amplifier cover parallel to the mainframe. DO NOT PULL DIRECTLY UP AS THE CONNECTOR MUST FIRST BE DISENGAGED.

The beam cover (pen lift bar, Item 17 Page 28) need only be removed for cleaning. Remove rear panel (Item 1 Page 22). Detach pen lift linkage and pivot scale out of way.



MAINTENANCE

LUBRICATION: NEVER oil or grease any parts, bearings or slides. All parts are either permanently lubricated or of low friction design. Adding lubricants actually increases friction by providing a perfect trap for dust or contaminants. If a bearing or race is obviously causing friction or binding, then it should be cleaned thoroughly. If still below par in operation, replace, rather than lubricate.

CLEANLINESS: A plastic dust cover is supplied for all bench applications.

Should a dirt buildup occur, use alcohol (isopropyl) and ear swabs or pipe cleaners. Clean all pulley grooves. Remove the beam pen lift plate and clean grooves in beam. If dirt is in or around the bearing edges, flush out using a syringe and alcohol. In other words clean all surfaces that are active.

PEN MECHANISM: Two adjustments are available — pen pressure and lift. The pressure adjustment is readily available to suit individual user taste. The pen lift should rarely, if ever, need be touched, unless some component is replaced.

PEN PRESSURE: Complete adjustment is made with the exposed screw on the opposite side of beam from the cartridge clip. Pressure is increased by turning CW. Ideal pen pressure is approximately 1 oz. (28 grams). This may be easily measured, using a phono needle gage. This pressure is the best compromise to give long life of the pen and a clear trace throughout a variety of slewing speeds. Occasionally, on max speed traces, a slight skipping will occur at this pressure. This can be corrected by increasing the pen pressure slightly with some sacrifice in pen life and broadening of the trace on slower speeds.

PEN LIFT: Clearance of the pen over the paper is independent of pen pressure. Normally 3/32 inch (2.4 mm) is ideal. Adjustment is on the side after removing the recorder rear side panel. Adjustment is controlled by position of the solenoid holding bracket held by screws in slots.

EVENT MARKER: Three adjustments are available — event pressure, event lift and event marker height. Pressure of the marker is adjusted exactly as per the recording pen. Lift is set by the mating of parts, item 29 and 24 page 29. The lift height should be set as close as possible to that of the recording pen (as both are lifted by the same bar). Event stroke is governed by the position of the solenoid bracket, item 22 page 29. Do not allow the marker to go beyond the sprocket hole edges.

ROLLER CLUTCH: A slip clutch is incorporated within the paper take-up roller. No adjustment is required unless the paper does not take up evenly. If paper is not firm on take-up core, remove slip clutch assembly from roller by loosening two set screws and increase spring load by moving truarc ring in approximately 1/16". If paper is taking up too tightly or pulling paper over sprocket teeth, reduce spring load 1/16".

Y1 AXIS REBALANCE POTENTIOMETER: Remove the service panel on the underside of the recorder by removing four screws as follows (see picture below):

1. One 8–32 Flat Head screw accessed by removing the Type 52 Chart Drive Module.
2. One 6–32 Binding Head screw just to the rear of the edge of the Y2 Pen Assembly cutout.
3. Two screws that attach the two front rubber feet to the service panel and bottom of the recorder. The service panel and remaining modules can now be lifted away from the recorder.

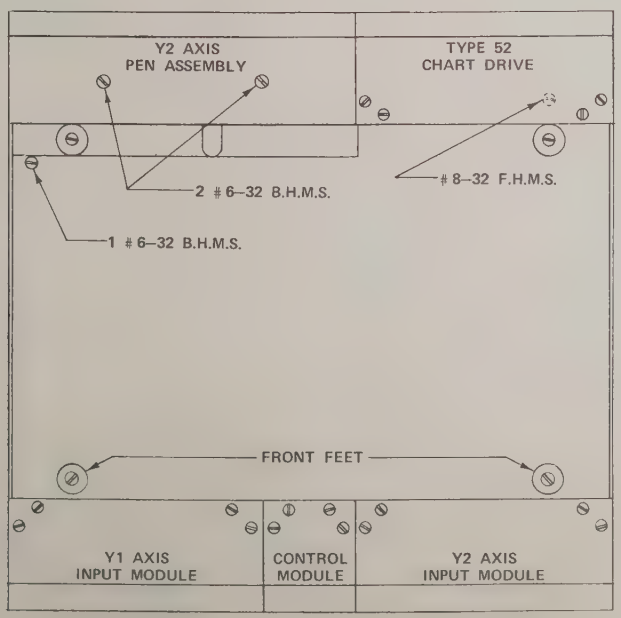
The motor/potentiometer assembly is located in the front center portion of the recorder. The potentiometer is replaced as follows:

4. Manually rotate the potentiometer CCW to the mechanical stops.
5. Loosen – about ½ turn – two 8–32 Bristol set screws nearest the potentiometer in the plastic coupling. DO NOT loosen the two screws farthest from the potentiometer. Remove the potentiometer.
6. Rotate the shaft of the replacement potentiometer CCW to its stops, then back off about 15^{o}.
7. Install the potentiometer and tighten the two set screws securing the shaft in the coupling.
8. Check to insure that the mechanical stops engage before the potentiometer stops make contact.

Check for proper operation. If operation is not correct refer to TROUBLE SHOOTING, Paragraphs 7, 8, 9 to locate fault. If operation is satisfactory, reinstall service panel.

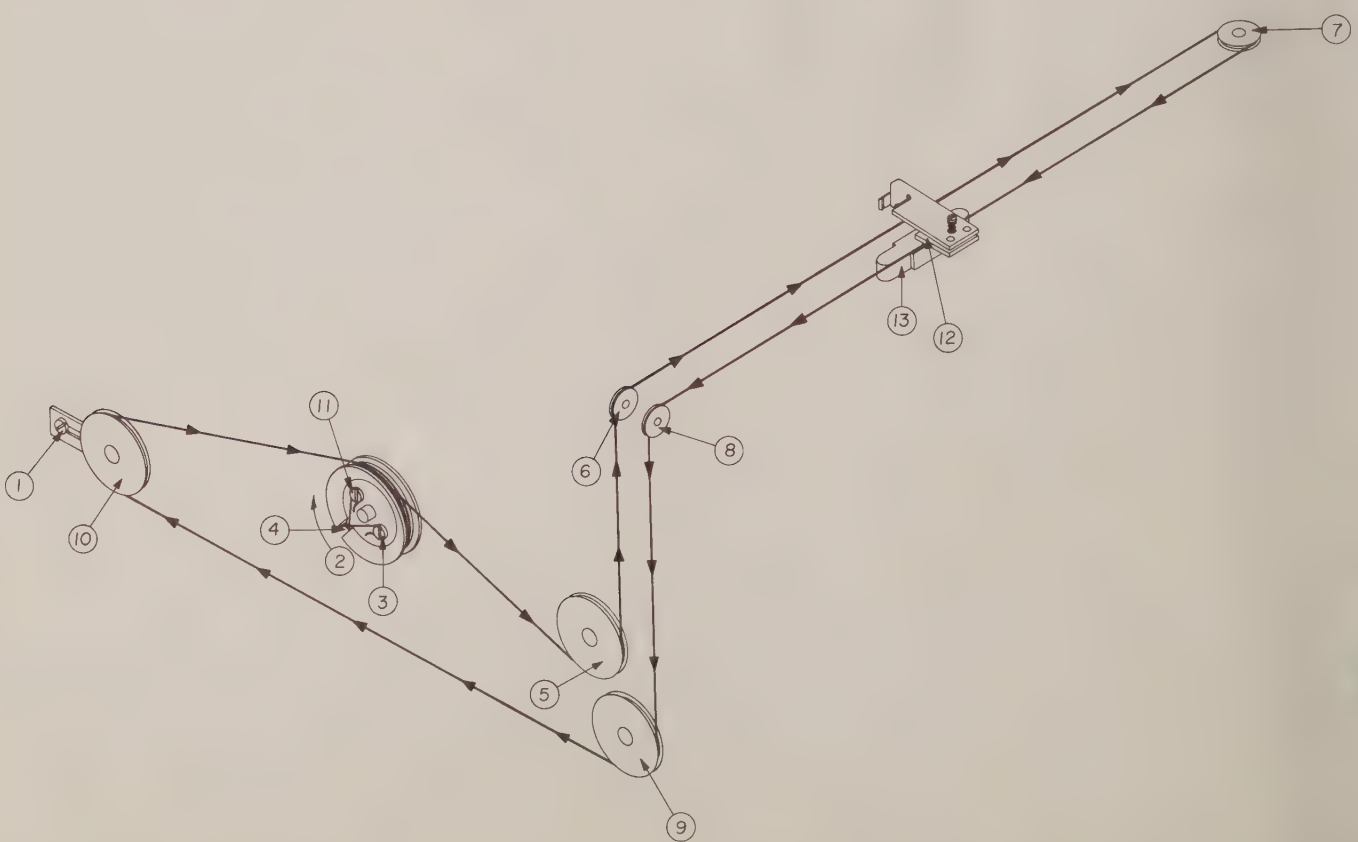
SERVO MOTOR: Located on the motor pot assembly, access is by removing the recorder bottom (see page 16 – Bottom). FIRST, remove the screws holding the plastic mounting piece. This should allow the motor with plastic mounting piece and drive gear to be withdrawn. Now remove the gear and mounting piece from the defective motor. Connect the mounting piece to the new motor and lightly set the gear. Re-install, but do not tighten the mounting piece screws. After insuring that the gears are aligned, tighten the drive gear to the motor shaft. Now carefully move the entire assembly sideways, so that the gear mesh is snug, but with some backlash to the larger gear. Tighten mounting screws. Meshing of the gears is not critical, but is important. Too tight, and binding will occur. Too loose, and sloppy traces will occur.

Y2 AXIS REBALANCE POTENTIOMETER AND SERVO MOTOR: Remove Y2 Axis Pen Assembly cover by removing two 6–32 Binding Head screws located in underside of the cover and rotating the cover outward away from the recorder. DO NOT attempt to remove the Y2 Axis Pen Assembly; reinstallation requires special fixtures and procedures. With the cover removed the motor and rebalance potentiometer are exposed. To replace the rebalance potentiometer follow steps 4 – 8 describing replacement of the Y1 Axis rebalance potentiometer. To replace the servo motor refer to the instructions for replacing the Y1 Axis servo motor.



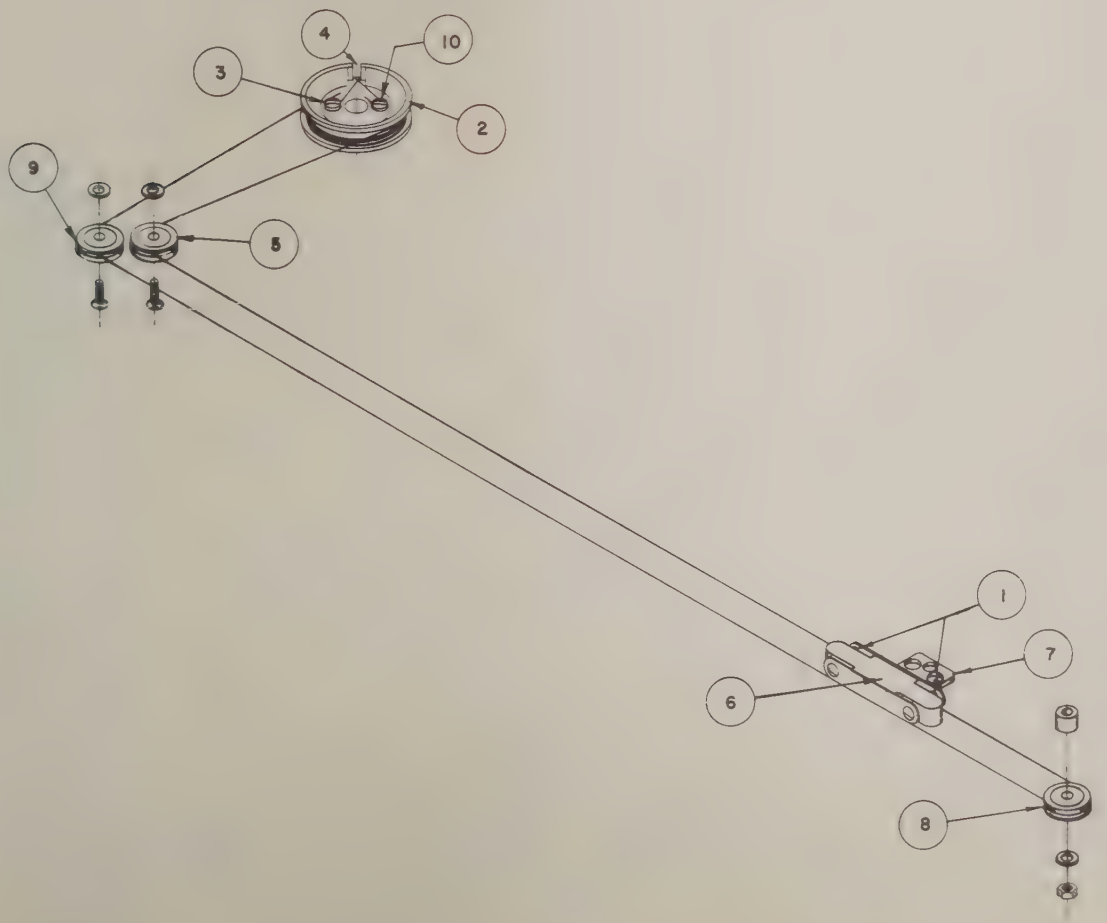
RE–CABLING Y–1

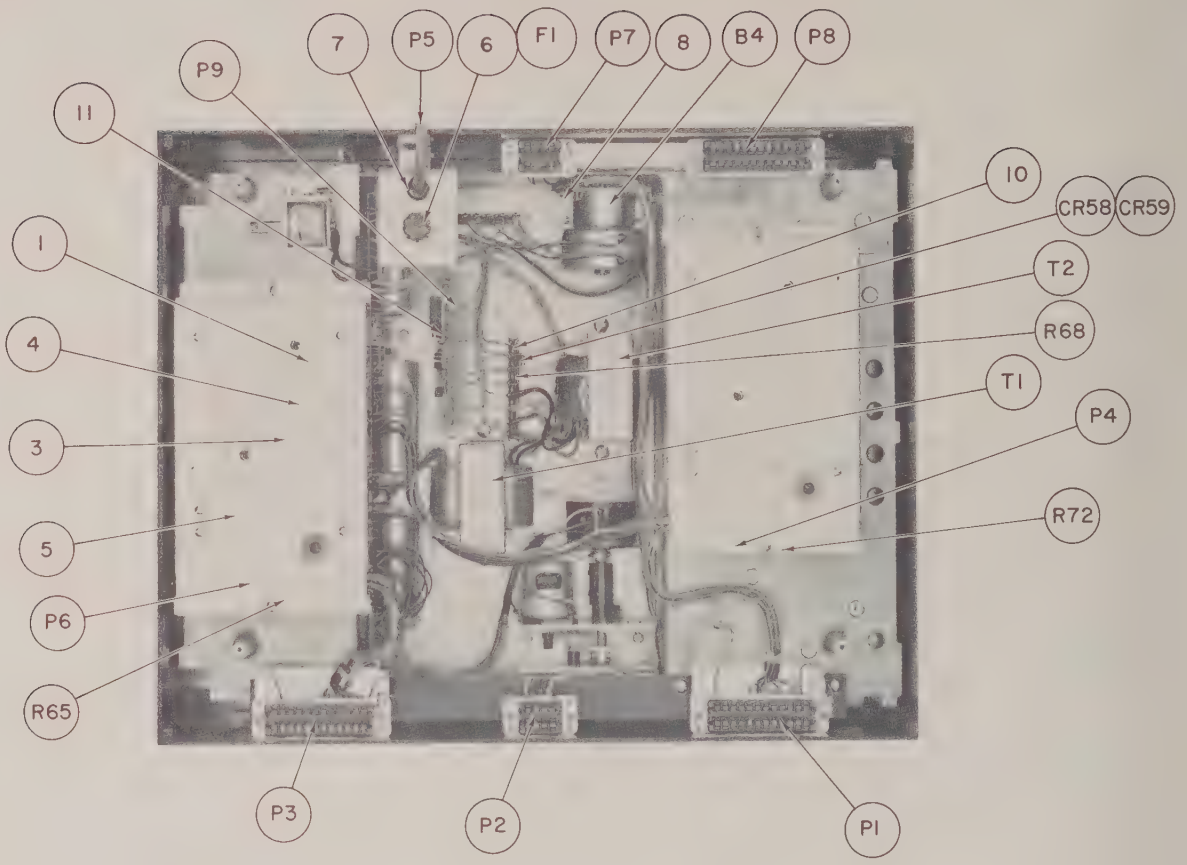
1. Remove molded side plates.
2. Remove Pen Holder Assembly and Event Marker Holder Assembly.
3. Detach pen lift linkage and pivot scale out of way.
4. Remove old cable.
5. Loosen cable tension bracket screw (1).
6. Turn drive pulley (2) clockwise to stop.
7. Attach new cable under drive pulley screw (3).
8. Route cable thru slot (4) and proceed CW to pulley (5).
9. Run cable CCW around pulley (5).
10. Run cable CW around pulley (6).
11. Run cable CW around pulley (7).
12. Run cable CCW around pulley (8).
13. Run cable CW around pulley (9).
14. Run cable CW around pulley (10).
15. Wrap 3½ turns CW around drive pulley (2) from side next to recorder and wrapping away from recorder and attach under screw (11).
16. Set cable tension at screw (1).
17. Position Pen Slider Assembly (13) with Pen Holder Assembly (12) and pen in place approximately 3/32 below bottom grid line on chart paper to achieve proper location and clamp cable.
18. Pivot scale back into place and attach to pen lift linkage.
19. Reinstall Pen Holder Assembly and Event Marker Holder Assembly.
20. Reattach molded side plates.



RE–CABLING Y–2

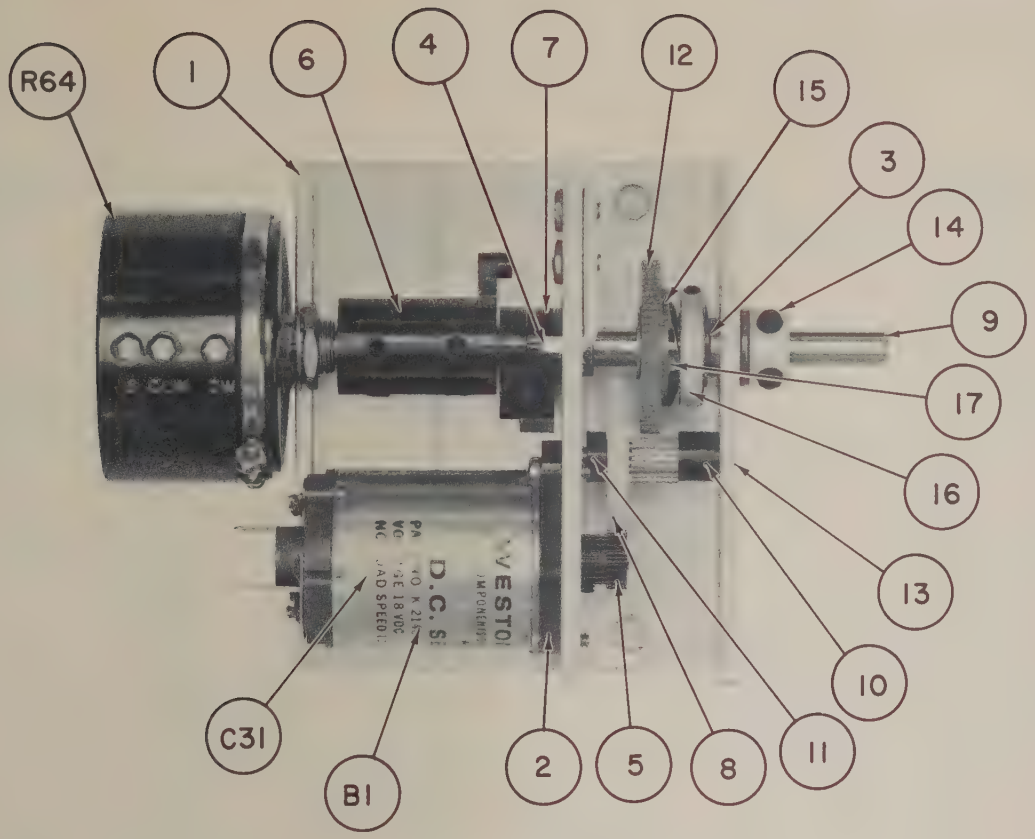
1. Remove cover from Y–2 Pen Assembly described on page 17.
2. Loosen two (1) screws at pen slider assembly (6).
3. Remove old cable.
4. Turn drive pulley (2) CW to stop. Do not reposition drive pulley with reference to shaft.
5 Attach new cable under drive pulley screw (3) and thru drive pulley slot (4).
6. Make one full wrap CW around drive pulley.
7. Run cable CCW around pulley (5).
8. Run cable between pen slider assembly (6) and pen holder assembly (7).
9. Run cable CW around pulley (8).
10. Run cable CW around pulley (9).
11. Rotate drive pulley CCW to stop.
12. Wrap cable approximately ½ turn CW.
13. Thread end of cable thru drive pulley slot (4) and CW around screw (10).
14. Cable should have ¼ inch deflection.
15. Rotate drive pulley CW to stop.
16. Move pen slider assembly so that pointer is approximately 1/16 inch below "0" on scale.
17. Tighten 2 screws (1).





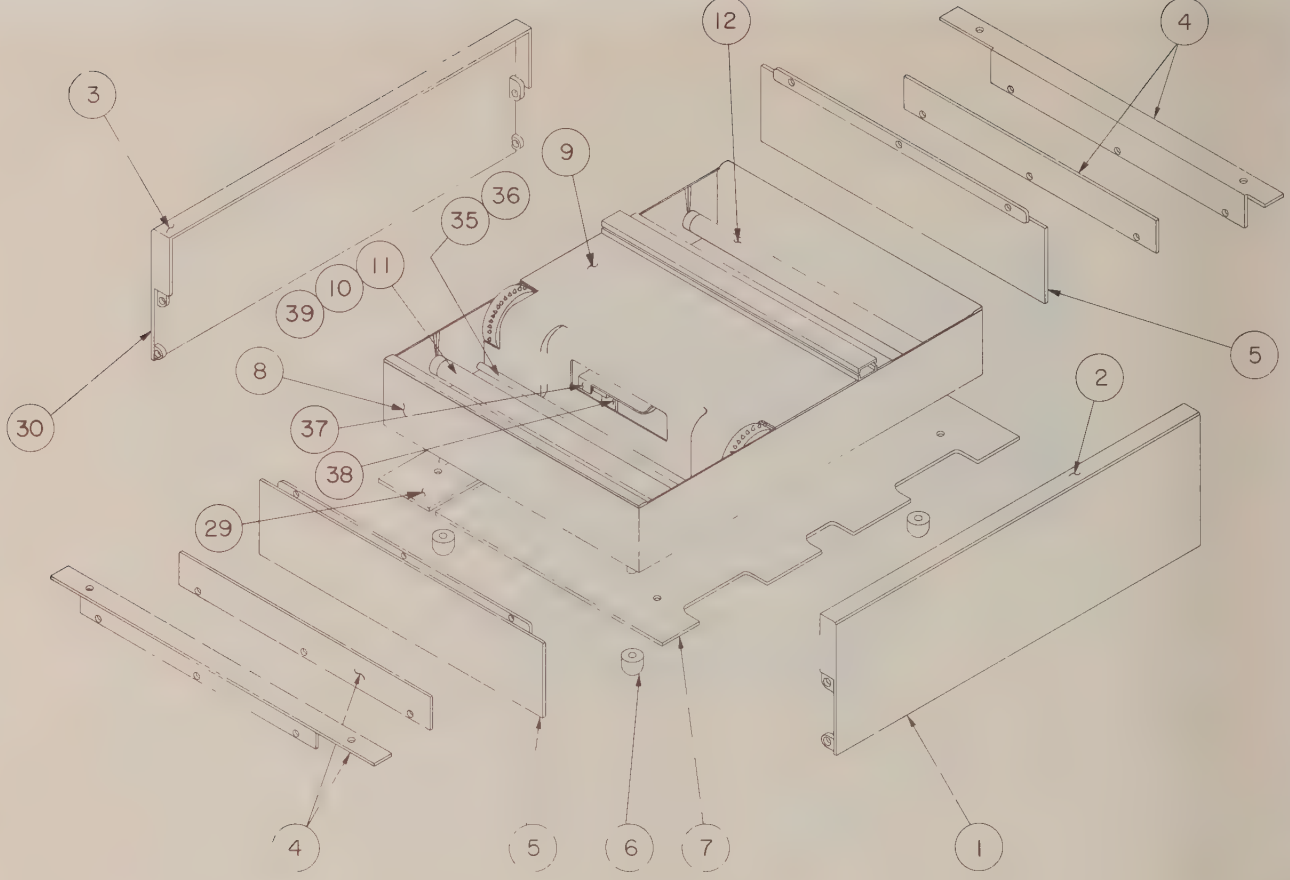
PARTS LIST

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
1	2000-332	1	Amplifier Assembly	Houston Instrument
2	3000-71	1	Power Supply Board Assembly	Houston Instrument
3	2000-50	2	Bottom Cover	Houston Instrument
4	2000-51	4	Insulator Block Amplifier	Houston Instrument
5	2000-52	4	Standoff Connector	Houston Instrument
6	MF-13	1	Fuse Holder	Littlefuse 342014
7	MS-369	1	Strain Relief Bushing	Heyco SR-16-1
8	3000-87	1	Mount Motoe	Houston Instrument
9	MB-2005	1	Terminal Strip	Cinch Jones 2005
10	MB-2008	1	Terminal Strip	Cinch Jones 2008
11	3000-262	1	Stepper Driver Assembly	Houston Instrument
B4	MM-95	1	Motor Stepper	A. W. Hayden K-82502
CR58	MD-8	2	Diode IN 837	I.T.T. Semiconductor
CR59			Same As CR58	
F1	MF-14	1	Fuse 1½ Amp 3 AG Slo-Blo	Littelfuse
P1	MC-826	1	Connector	Amphenol 26-4200-24S
P2	MC-827	1	Connector	Amphenol 26-4200-8S
P3	MC-826	1	Connector	Amphenol 26-4200-24S
P4	MC-828	1	Connector	Viking 2VK-22S/1-1
P5	MC-710	1	Power cord	Riechart Elec PWC-18-3
P6	MC-828	1	Connector	Viding 2VK-22S/1-1
P7	MC-827	1	Connector	Amphenol 26-4200-8S
P8	MC-826	1	Connector	Amphenol 26-4200-24S
P9	MC-828	1	Connector	Viking 2VK-22S/1-1
R65	MR-1031	1	Resistor 23.2K - 1% - ½W - MF	Corning
R68	MR-932	1	Resistor 270 Ohm - 10% - 2W - Composition	Allen Bradley
R72	MR-1031	1	Resistor 23.2K - 1% - ½W - MF	Corning
T1	2000-438	1	Transformer - Power	Grand S-3160A
T2	3000-65	1	Transformer - Pen	Heeco 6793



PARTS LIST

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
1	2000-24	1	Base - Pen Drive	Houston Instrument
2	2000-20	1	Sub Plate - Motor Mount	Houston Instrument
3	MB-7	2	Bushing	Boston FB-46-2
4	2000-160	1	Stop - Counting	Houston Instrument
5	2000-88	1	Pinion Spur (2-3000 Series Only)	Houston Instrument
5	2000-89	1	Pinion Spur (2-3011 Series Only)	Houston Instrument
6	2000-18	1	Coupling	Houston Instrument
7	2000-19	2	Floating Counting Stop	Houston Instrument
8	2000-441	1	Spur Gear	Houston Instrument
9	2000-146	1	Drive Shaft	Houston Instrument
10	2000-36-1	1	Spacer	Houston Instrument
11	2000-36-2	1	Spacer	Houston Instrument
12	2000-21	1	Gear and Pinion Assembly	Houston Instrument
13	2000-17	1	Shaft Intermediate	Houston Instrument
14	2000-169	1	Collar - Drive Shaft	Houston Instrument
15	2000-80	1	Spring - Slip Clutch	Houston Instrument
16	2000-139	1	Collar Slip Clutch	Houston Instrument
17	2000-156	1	Clutch Disc to Pin assembly	Houston Instrument
B1	2000-394	1	Motor (Ball Bearing) (2-3000 Series Only)	Houston Instrument
B1	MM-96	1	Motor (Ball Bearing) (2-3011 Series Only)	Weston K-214650-1-1-10-1
C31	MC-480	1	Capacitor - 0.1 MFD - 200 V - 5%	Paktron MB800
R66	MP-398	1	Potentiometer - Rebalance 2K - 3 Turn	Duncan 3605R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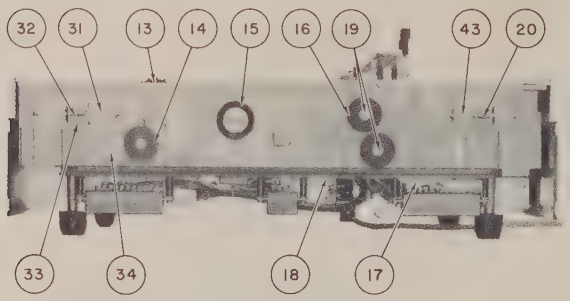
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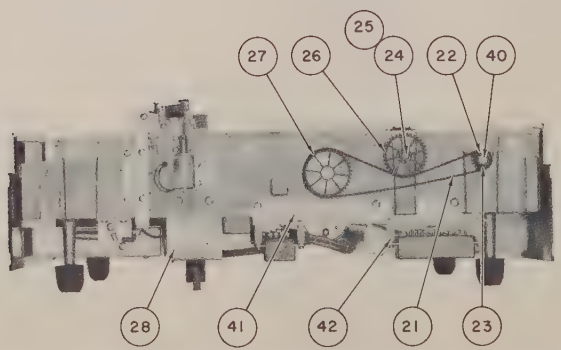
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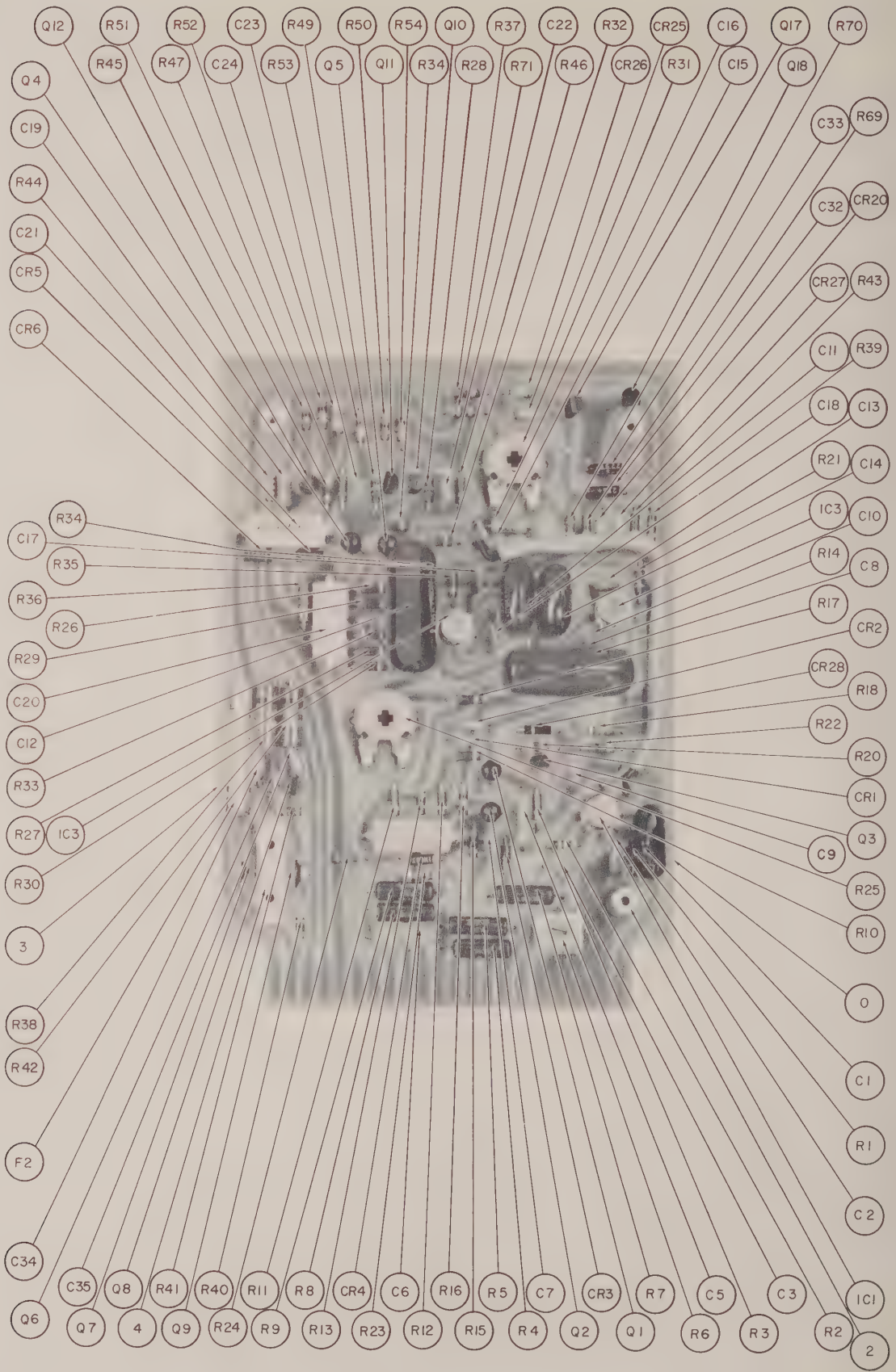
PARTS LIST

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
1	2000-16	1	Front Plate Molding	Houston Instrument
2	3000-180	1	Decal OMNIGRAPHIC®	Houston Instrument
3	3000-179	1	Decal Blank	Houston Instrument
4	2000-195	1	Rack Mount Right - With Modules	Houston Instrument
4	2000-196	1	Rack Mount Left - With Moudules	Houston Instrument
4	2000-342	2	Rack Mount - Without Modules	Houston Instrument
4	3000-52	2	Rack Mount — With Modules & Y2 Pen	Houston Instrument
5	2000-13	2	Side Plate Molding	Houston Instrument
6	MR-610	4	Rubber Feet	Rubbercraft 910Z-R
7	3000-11	1	Service Panel	Houston Instrument
8	3000-430	1	Recording Body	Houston Instrument
9	3000-29	1	Platen	Houston Instrument
10	3000-46	1	Roller - Feed Out	Houston Instrument
11	3000-3	1	Rod - Paper Feed Out Assembly	Houston Instrument
12	3000-4	1	Rod - Paper Take Up Assembly	Houston Instrument
13	3000-90	2	Support	Houston Instrument
14	2000-169	1	Collar	Houston Instrument
15	3000-75	1	Pulley - Pen Drive	Houston Instrument
16	2000-3	3	Pulley	Houston Instrument
17	2000-193	2	Shield - Connector	Houston Instrument
18	2000-218	1	Connector Bracket	Houston Instrument
19	3000-67	2	Spacer - Pulley	Houston Instrument
20	3000-41	1	Shaft - Right Spacer Roller	Houston Instrument
21	MG-1	1	Chain 15"	Serv-O-link
22	MG-57	1	Sprocket No. 16 x ¼	Serv-O-link
23	MB-8	1	Bearing	Fafnir FS1KDD7
24	MB-7	2	Bushing	Boston FB-46-2
25	3000-91	1	Shaft Sprocket	Houston Instrument
26	MG-55	1	Sprocket No. 36 x ¼	Serv-O-link
27	3000-89	1	Sprocket Modified	Houston Instrument
28	3000-197	1	Bracket - Power Plug	Houston Instrument
29	3000-126	1	Sub Plate	Houston Instrument
30	3000-145	1	Cover Plate Modified	Houston Instrument
31	3000-43	6	Roller Inner	Houston Instrument
32	3000-44	1	Shaft Left Spacer Roller	Houston Instrument
33	3000-431	3	Bushing - Reel Pen	Houston Instrument
34	3000-147	1	Mount Adj. Pulley	Houston Instrument
35	3000-391	1	Paper Guide	Houston Instrument
36	3000-408	1	Washer - Paper Guide	Houston Instrument
37	3000-93	1	Spring - Paper Feed Out	Houston Instrument
38	3000-112	1	Mount - Feed Out Spring	Houston Instrument
39	MB-68	3	Belt - Feed Out	Walsco 1414
40	3000-39	1	Drive Coupling - Reel Pin	Houston Instrument
41	3000-32	1	Connector Mounting Bracket	Houston Instrument
42	3000-42	4	Standoff	Houston Instrument
43	3000-66	2	Roller - Large	Houston Instrumnet


Q12
R51
R52
C23
R49
R50
R54
Q10
R37
C22
R32
CR25
C16
Q17
R70
R45
R47
C24
R53
Q5
Q11
R34
R28
R71
R46
CR26
R31
C15
Q18
Q4
C19
R44
C21
CR5
CR6
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R69
C32
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C11
R39
C18
C13
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IC3
C10
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C8
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CR2
CR28
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IC1
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Q1
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Q8
C35
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Q7
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CR4
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R42
R38
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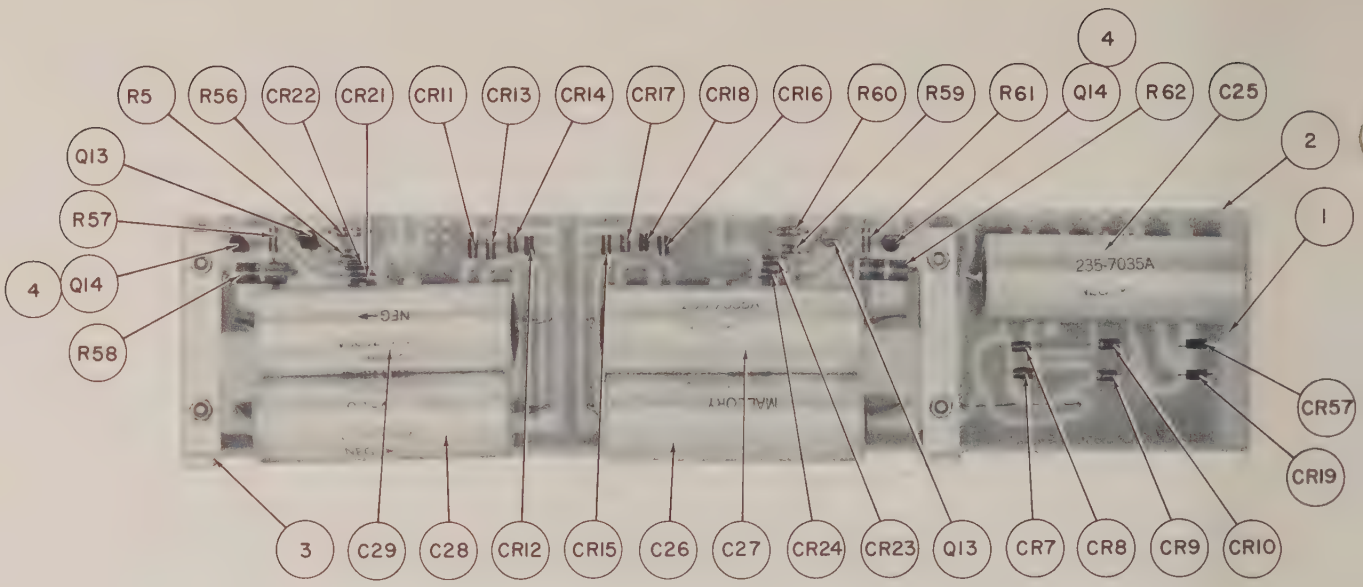
R30
R27
IC3
R33
C12
C20
R29
R36
R26
R35
C17
R34

AMPLIFIER

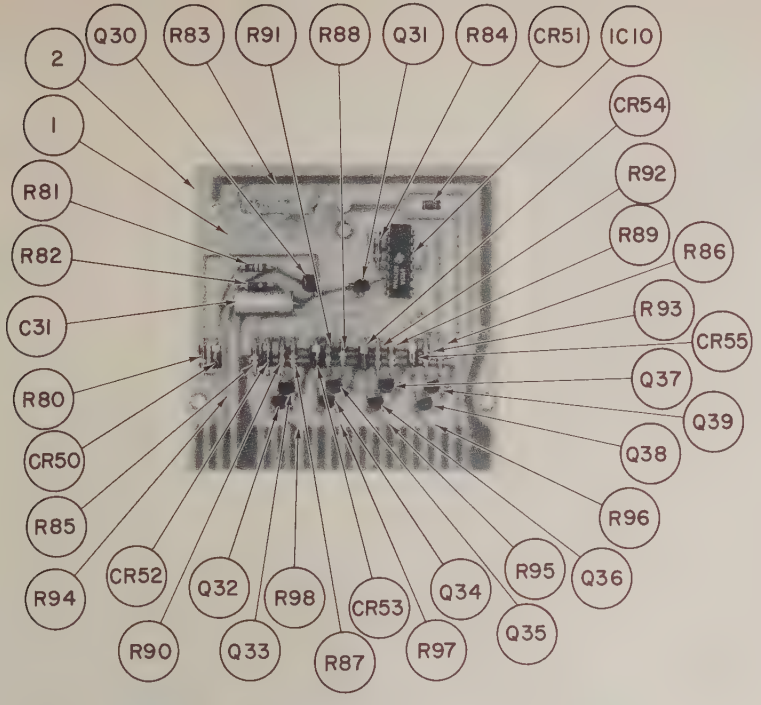
AMPLIFIER PARTS LIST

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
0	2000-332	1	Circuit Board - Assembly	Houston Instrument
1	2000-49	1	Cover (Not Shown)	Houston Instrument
2	2000-53	3	Standoff	Houston Instrument
3	2000-263	1	Circuit Board	Houston Instrument
4	2000-397	1	Heat Sink	Houston Instrument
C1	MC-480	3	Capacitor - .1 MFD - 200V - 5%	Paktron MB800
C2	MC-579	4	Capacitor - .001 MFD - 1000V - 10% - Ceramic	Sprague
C3	MC-229	2	Capacitor - .01 MFD - 200V - 10% Pacer	Sprague
C4	MC-542	1	Capacitor - 10 MFD - 35V - 10% - Electrolytic	Mallory
C5	MC-186	1	Capacitor - .0047 MFD - 200V - 10% - Pacer	Sprague
C6	MC-190	1	Capacitor - .047 MFD - 200V - 10% - Pacer (2–3000 Series Only)	Sprague
C6	MC-191	1	Capacitor - .039 MFD - 200V - 10% - Pacer (2–3011 Series Only)	Sprague
C7	MC-156	1	Capacitor - .10 PFD - 1000V - 20% - Ceramic	Sprague
C8	MC-157	2	Capacitor - 1.0 MFD - 200V - 20% - Mylar	Paktron
C9	MC-545	1	Capacitor - .005 MFD - 50V - 20% - Ceramic	Sprague
C10			Same As C2	
C11			Same As C1	
C12			Same As C8	
C13	MC-183	4	Capacitor - 200 PFD - 1000V - 20% - Ceramic	Sprague
C14			Same As C1	
C15	MC-409	4	Capacitor - .001 MFD - 200V - 10% - Pacer	Sprague
C16			Same As C15	
C17			Same As C3	
C18			Same As C13	
C19			Same As C15	
C20	MC-481	2	Capacitor - 50 MFD - 6V - Electrolytic	Mallory
C21			Same As C20	
C22			Same As C13	
C23			Same As C13	
C24			Same As C15	
C32	MC-471	2	Capacitor - 2.2 MFD - 20V - 30% - Ceramic	Sprague
C33			Same As C25	
C34			Same As C2	
C35			Same As C2	
CR1	MD-8	6	Diode - 1N837	ITT Semiconductor
CR2			Same As CR1	
CR3	MD-10	2	Diode - Zener - 9V - 1N937	Motorola
CR4			Same As CR3	
CR5	MD-27	2	Diode - 2.5V - 1N15222A	Motorola
CR6			Same As CR5	
CR20			Same As CR1	
CR25			Same As CR1	
CR26			Same As CR1	
CR27			Same As CR1	
CR28	MD-95	1	Diode - Zener - 1N5232A	Motorola
F2	MF-41	1	Fuse - 1 Amp - 3 AG - Pigtail	Littelfuse
IC1	MW-132	1	Integrated Circuit MEM2008	General Inst.
IC2	MW-117	2	Integrated Circuit MC1709CG	Motorola
IC3			Same As IC2	
Q1	MQ-48	4	Transistor - 2N5163	Fairchild
Q2			Same As Q1	
Q3	MQ-28	4	Transistor - MPS6531	Motorola
Q4			Same As Q1	
Q5			Same As Q1	
Q6			Same As Q3	
Q7	MQ-47	1	Transistor - 2N4921	Motorola
Q8	MQ-29	1	Transistor - MPS6534	Motorola
Q9	MQ-46	1	Transistor - 2N4918	Motorola
Q10			Same As Q3	
Q11			Same As Q3	
Q12	MQ-44	1	Transistor - D13T1	General Electric
Q17	MQ-66	1	Transistor - 2N5461-1A	Motorola
Q18	MQ-63	1	Transistor - 2N5457-2A	Motorola
R1	MR-111	1	Resistor - 1K - ¼W - 10% - Composition	Allen Bradley
R2	MR-114	2	Resistor - 10K - ¼W - 10% - Composition	Allen Bradley
R3	MR-190	2	Resistor - 2.2 Meg - ¼W - 10% - Composition	Allen Bradley
R4	MR-239	1	Resistor - 11K - ½W - 1% - Metal Film	Corning
R5	MR-1026	1	Resistor - 383K - ½W - 1% - Metal Film	Corning
R6	MR-381	1	Resistor - 10K No. 53-1-1-103/360T103B	Spectrol/CTC
R7	MR-1025	1	Resistor - 3.82K - ½W - 1% - Metal Film	Corning
R8	MR-1027	1	Resistor - 392K - ½W - 1% - Metal Film	Corning
R9	MR-1028	1	Resistor - 34.8K - ½W - 1% - Metal Film	Corning
R10	MR-1035	4	Resistor - 8.2K - ¼W - 10% - Composition	Allen Bradley
R11	MR-118	4	Resistor - 2.2K ¼W - 10% - Composition	Allen Bradley
R12			Same As R10	
R13	MR-840	4	Resistor - 47 Ohm - ¼W - 10% - Composition	Allen Bradley
R14	MR-136	5	Resistor - 1.5K - ¼W - 10% - Composition	Allen Bradley
R15	MR-598	2	Resistor - 1 Meg - ¼w - 10% - Composition	Allen Bradley
R16			Same As R2	
R17			Same As R15	
R18	MR-137	1	Resistor - 6.8K ¼W - 10% - Composition	Allen Bradley
R19			Not Assigned	
R20	MR-1069	1	Resistor - 4.3K - ¼W - 5% - Composition	Allen Bradley
R21			Same As R13	
R22	MR-996	1	Resistor - 100 Ohm - ¼W - 10% - Composition	Allen Bradley
R23	MR-822	1	Resistor - 830 Ohm - ¼W - 5% - Composition	Allen Bradley
R24	MR-927	1	Resistor - 470 Ohm - ¼W - 5% - Composition	Allen Bradley
R25	MP-382	1	Potentiometer - 5K - MTC-53L4	Mallory
R26			Same As R14	
R27			Same As R14	
R28			Same As R11	
R29			Same As R10	
R30			Same As R10	
R31	MP-383	1	Potentiometer - 2K - MTC23L4	Mallory
R32	MR-816	1	Resistor - 1.8K - ¼W - 10% - Composition	Allen Bradley
R33			Same As R3	
R34	MR-142	1	Resistor - 39K - ¼W - 10% - Composition	Allen Bradley
R35			Same As R14	
R36	MR-93	1	Resistor - 270 Ohm - ½W - 10% - Composition	Allen Bradley
R37	MR-815	1	Resistor - 3.3K - ¼W - 10% - Composition	Allen Bradley
R38	MR-997	2	Resistor - 200 Ohm - 1W - 10% - Composition	Allen Bradley
R39	MR-984	2	Resistor - 2.7 Meg - ¼W - 5% - Composition	Allen Bradley
R40	MR-125	2	Resistor - 4.7K - ¼W - 10% - Composition	Allen Bradley
R41			Same As R40	
R42			Same As R38	
R43	MR-960	2	Resistor - 2.2 Meg - ¼W - 5% - Composition	Allen Bradley
R44	MR-188	1	Resistor - 390K - ¼W - 5% - Composition	Allen Bradley
R45	MR-482	1	Resistor - 2.7K - ¼W - 5% - Composition	Allen Bradley
R46			Same As R11	
R47			Same As R11	
R48	MR-117	4	Resistor - 100K - ¼W - 10% - Composition	Allen Bradley
R49			Same As R48	
R50			Same As R13	
R51			Same As R13	
R52	MR-1123	1	Resistor - 5.1K - ¼W - 5% - Composition	Allen Bradley
R53			Same As R48	
R54			Same As R48	
R69			Same As R43	
R70			Same As R39	
R71			Same As R14	



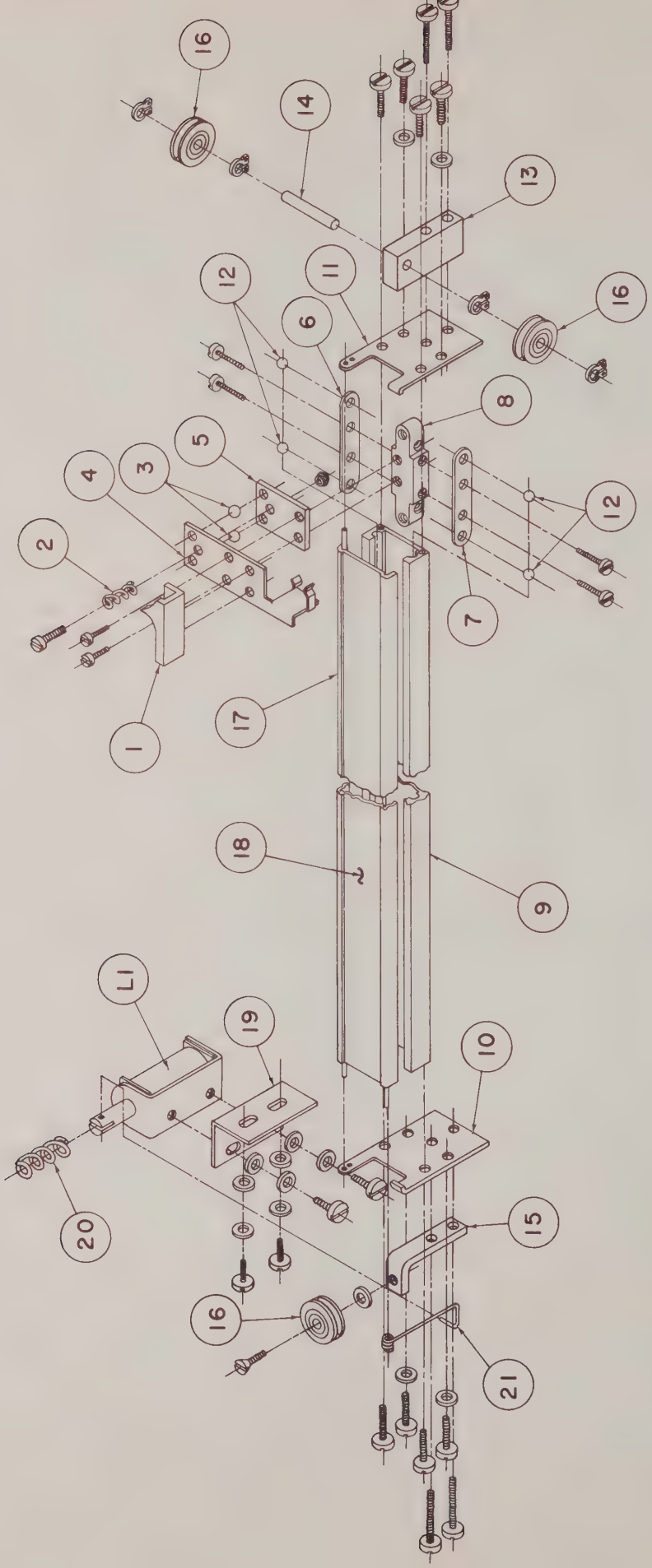
POWER SUPPLY PARTS LIST

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
1	3000-71	1	Power Supply Board Assembly	Houston Instrument
2	2000-171	1	Power Supply Board Drilled	Houston Instrument
3	2000-121	2	Standoff	Houston Instrument
4	MH-24	1	Heat Sink	Wakefield 292-AP
C25	MC-184	5	Capacitor - 2100 MFD - 30 VDC - Electrolytic	Mallory
C26			Same As C25	
C27			Same As C25	
C28			Same As C25	
C29			Same As C25	
CR7	MD-25	14	Diode - 1N4005	Sarkes Tarzian
CR8			Same As CR7	
CR9			Same As CR7	
CR10			Same As CR7	
CR11			Same As CR7	
CR12			Same As CR7	
CR13			Same As CR7	
CR14			Same As CR7	
CR15			Same As CR7	
CR16			Same As CR7	
CR17			Same As CR7	
CR18			Same As CR7	
CR19			Same As CR7	
CR21	MD-19	4	Diode - 1N4744A	Simcor
CR22			Same As CR21	
CR23			Same As CR21	
CR24			Same As CR21	
CR57			Same As CR7	
Q13	MQ-28	2	Transistor - MPS-6531	Motorola
Q14	MQ-29	2	Transistor - MPS-6534	Motorola
Q15			Same As Q13	
Q16			Same As Q14	
R55	MR-421	4	Resistor - 47 Ohm - 1W - 15% - Composition	Allen Bradley
R56	MR-111	4	Resistor - 1K - ¼W - 5% - Composition	Allen Bradley
R57			Same As R56	
R58			Same As R55	
R59			Same As R55	
R60			Same As R56	
R61			Same As R56	
R62			Same AS R55	



STEPPER DRIVER BOARD PARTS LIST

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
1	3000-262	1	Stepper Driver Board Assembly	Houston Instrument
2	3000-182	1	Stepper Driver Board	Houston Instrument
C31	MC-542	1	Capacitor - 10 MFD - 35V	Mallory MTA-10D35
CR50	MD-8	1	Diode - IN837	ITT Semiconductor
CR51	MD-97	1	Diode - IN5338B	Motorola
CR52	MD-25	4	Diode - IN4005	Motorola
CR53			Same As CR52	
CR54			Same As CR52	
CR55			Same As CR52	
IC10	MW-118	1	Integrated Circuit - SN7476N	Motorola
Q30	MQ-44	1	Transistor - D13T1	General Electric
Q31	MQ-28	9	Transistors - MPS6531	Motorola
Q32			Same As Q31	
Q33			Same As Q31	
Q34			Same As Q31	
Q35			Same As Q31	
Q36			Same As Q31	
Q37			Same As Q31	
Q38			Same As Q31	
Q39			Same As Q31	
R80	MR-111	2	Resistor - 1K - ¼W - 5% - Composition	Allen Bradley
R81	MR-837	1	Resistor - 27K - ¼W - 5% - Composition	Allen Bradley
R82	MR-979	1	Resistor - 4.7K - ¼W - 5% - Composition	Allen Bradley
R83	MR-1094	1	Resistor - 50 Ohm - 12W - 5% - WW Brown Devil	Ohmite 200-12
R84			Same As R80	
R85	MR-470	5	Resistor - 10K - ¼W - 5% - Composition	Allen Bradley
R86			Same As R85	
R87			Same As R85	
R88			Same As R85	
R89			Same As R85	
R90	MR-482	4	Resistor - 2.7K - ¼W - 5% - Composition	Allen Bradley
R91			Same As R90	
R92			Same As R90	
R93			Same As R90	
R94	MR-118	1	Resistor - 2.2K - ¼W - 10% - Composition	Allen Bradley
R95	MR-1130	4	Resistor - 68 Ohm - 3W - 5% - W.W.	Ohmite
R96			Same As R95	
R97			Same As R95	
R98			Same As R95	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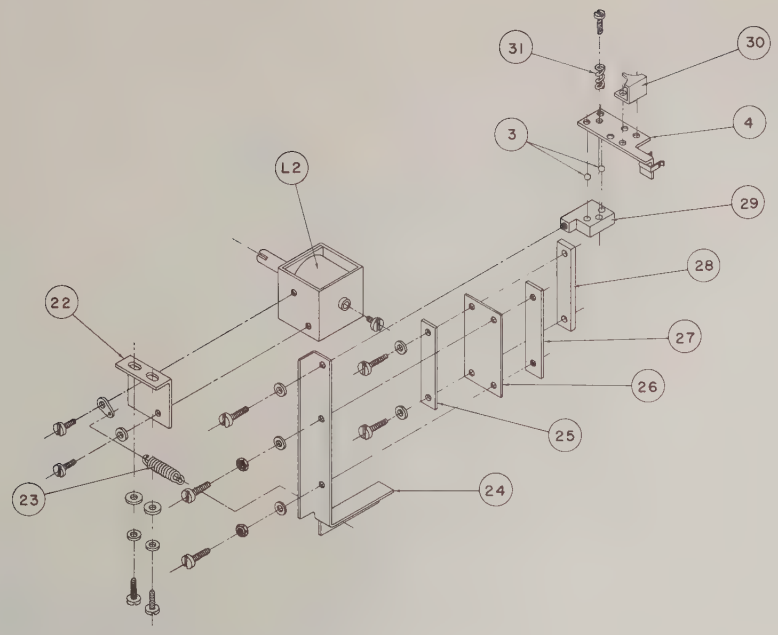
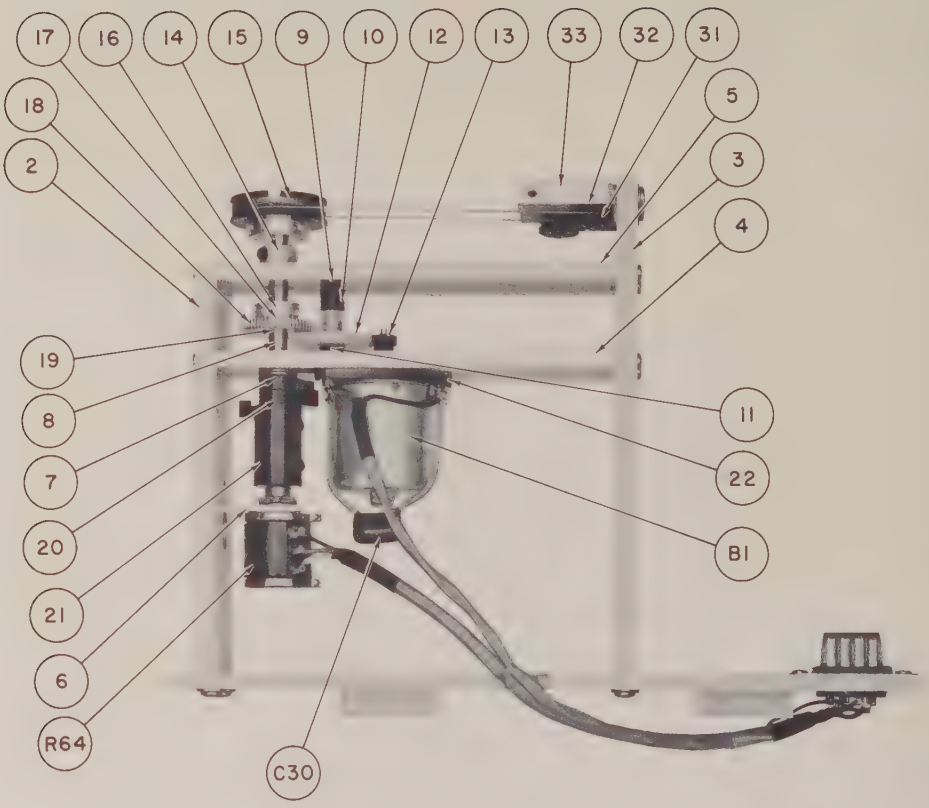


PARTS LIST

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
1	2000-325	1	Pointer	Houston Instrument
2	2000-192	1	Spring - Pen Pressure	Houston Instrument
3	MB-99	4	Ball - Chrome Gr. 200 - 3/16" Dia	Hartford Universal Co.
4	3000-50	2	Pen Holder - Assembly	Houston Instrument
5	2000-220	1	Mount - Pen Holder	Houston Instrument
6	2000-78-1	1	Cage - Ball	Houston Instrument
7	2000-78-2	1	Cage - Ball	Houston Instrument
8	2000-77	1	Slider Block	Houston Instrument
9	3000-79	1	Beam	Houston Instrument
10	3000-80-1	1	Beam and Scale Mount - Left	Houston Instrument
11	3000-26	1	Beam and Scale Mount - Right	Houston Instrument
12	MB-98	4	Ball - Nylon Grade 500 - 3/16 Dia	Hartford Universal Co.
13	3000-110	1	Pulley Mount - Lower	Houston Instrument
14	DP3-069	1	Shaft - Pulley	Houston Instrument
15	3000-84	1	Pulley Mount - Upper	Houston Instrument
16	2000-1	3	Pulley	Houston Instrument
17	3000-353	1	Scale - Sub Assembly	Houston Instrument
18	3000-181	1	Decal - Scale - English	Houston Instrument
18	3000-336	1	Decal - Scale - Metric	Houston Instrument
19	3000-118	1	Bracket - Solenoid	Houston Instrument
20	3000-72	1	Spring - Scale Lift	Houston Instrument
21	3000-386	1	Linkage - Scale Lift	Houston Instrument
22	3000-63	1	Bracket - Solenoid	Houston Instrument
23	3000-166	1	Return Spring	Houston Instrument
24	3000-142	1	Linkage - Event Assembly	Houston Instrument
25	3000-133	1	Clamp Plate	Houston Instrument
26	3000-134	1	Fixture - Linkage	Houston Instrument
27	3000-132	1	Clamp Plate	Houston Instrument
28	3000-138	1	Spacer - Linkage	Houston Instrumnet
29	3000-34	1	Mount - Event Pen	Houston Instrument
30	2000-192	1	Spring - Pen Press	Houston Instrument
31	3000-81	1	Pointer	Houston Instrument
L1	3000-355	1	Solenoid - Modified	Houston Instrument
L2	3000-64	1	Solenoid - Modified	Houston Instrument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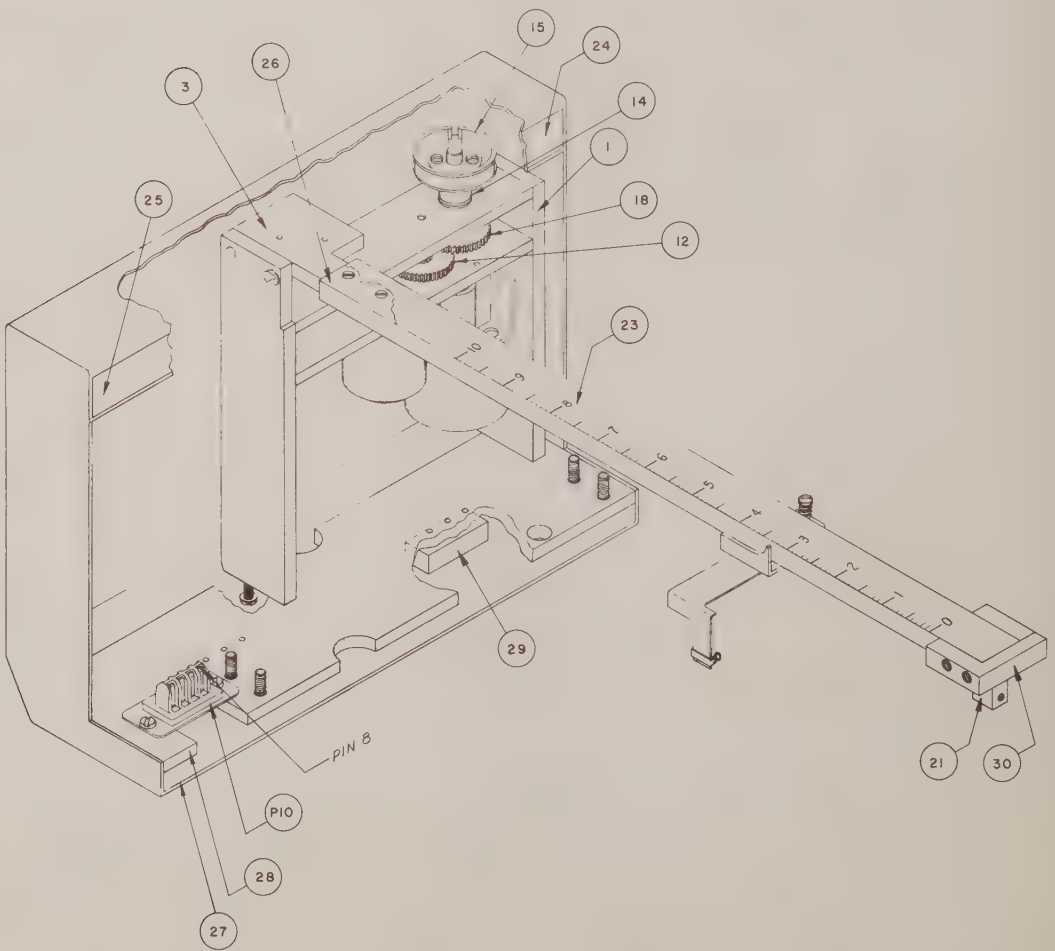
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PIN 8
P10
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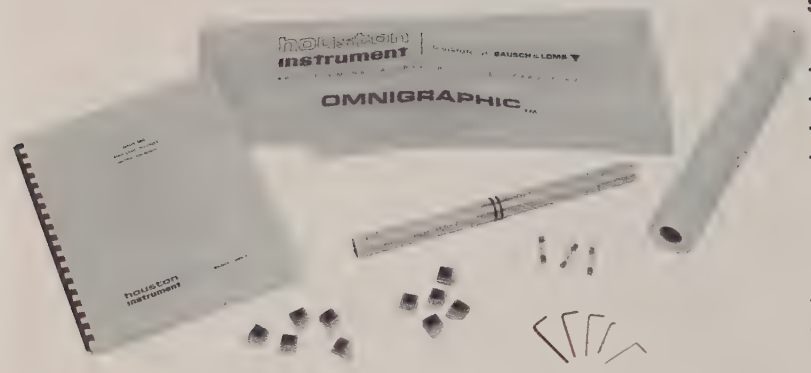
PARTS LIST

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
1	3000–35	1	Y2 Pen Axis Drive Assembly	Houston Instrument
2	3000–19	1	Cap - Y2 Motor Assembly	Houston Instrument
3	3000–16	1	Base - Y2 Motor Assembly	Houston Instrument
4	3000–22	1	Motor Flange - Y2 Pen	Houston Instrument
5	3000–23	1	Pulley Flange - Y2 Pen	Houston Instrument
6	3000–20	1	Stop - Y2 Pot	Houston Instrument
7	MB–7	2	Bushing	Boston FB-46-2
8	2000–9	1	Shaft - Drive	Houston Instrument
9	2000–17	1	Shaft - Intermediate	Houston Instrument
10	2000–36–1	1	Spacer	Houston Instrument
11	2000–36–2	1	Spacer	Houston Instrument
12	2000–21	1	Gear & Pinion Assembly	Houston Instrument
13	2000–12	1	Pinion Spur	Houston Instrument
14	2000–169	1	Collar Drive Shaft	Houston Instrument
15	3000–75	1	Pulley - Pen Drive	Houston Instrument
16	Not Assigned			
17	Not Assigned			
18	2000–143	1	Spur Gear	Houston Instrument
19	2000–145	1	Friction Plate	Houston Instrument
20	2000–19	2	Floating Counting Stop	Houston Instrument
21	2000–18	1	Coupling	Houston Instrument
22	2000–20	1	Sub Plate - Motor Mount	Houston Instrument
23	3000–59	1	Decal - English	Houston Instrument
23	3000–58	1	Decal - Metric	Houston Instrument
24	3000–57–2	1	Decal - Cover	Houston Instrument
25	3000–57–1	1	Decal - Cover	Houston Instrument
26	3000–36	1	Beam - Y2	Houston Instrument
27	3000–10	1	Cover - Y2 Motor Assembly	Houston Instrument
28	3000–12	1	Chassis - Motor Assembly Mounting	Houston Instrument
29	3000–51	2	Spacing Block	Houston Instrument
30	3000–48	1	Decor Block	Houston Instrument
31	2000–5	3	Pulley Beam	Houston Instrument
32	3000–14	1	Spacer Pulley	Houston Instrument
33	3000–77	1	Slider Block	Houston Instrument
C30	MC–480	1	Capacitor - 0.1 MFD - 200V - 5%	Packtron MB-800
B1	2000–391	1	Motor	Houston Instrument
P10	MC–827	1	Connector	Amphenol 126-4200-8P
R64	MP–398	1	Potentiometer - 2K - 3 Turn - .25% Lin.	Duncan 3605



STANDARD ACCESSORIES SUPPLIED

- Instruction Manual
- Dust Cover — Flexible
- Roll Chart Paper
- Accessory Kit containing:
  - 5 Red pens
  - 5 Black pens
  - 3 Fuses
  - Set of Bristol Wrenches
- Roll Paper Take-Up Tube
- Positive Feed Grip Tube

SUPPLIES

PENS: All pens are disposable and snap into the recorder pen bracket. Each pen includes its own long life ink supply. Replacement or color substitution is made in seconds. There is never any cleaning or ink handling problems.

CAT. NO.	DESCRIPTION	PACKET PRICE
P–40	Packet 10 pens — red	$12.00
P–41	Packet 10 pens — blue	12.00
P–42	Packet 10 pens — green	12.00
P–43	Packet 10 pens — black	12.00
P–52	Packet 10 pens — black & red	12.00

ORDERING

SUPPLIES	Specify quantity, catalog number & description.
PARTS	Specify quantity, Houston Instrument part number, serial number of instrument.
ORDER	In the United States — to Houston Instrument or care of local representative.
	Outside United States — only from local distributor.

PAPER: Exceptional dimensional stability combined with precision grid printing is inherent to OMNIGRAPHIC® paper. Popularly used paper is listed below. See Recording Supplies Bulletin for other types.

CAT. NO.	DESCRIPTION	PRICE/ROLL
RC–109	Y axis 10 major divisions in inches X axis 100′ long, 1 inch major divisions	$3.90
RC–110	Y axis 25 cm (1 cm/major division) X axis 100′ long, 1 inch major divisions	3.90

WARRANTY

Houston Instrument warrants unconditionally for 1 year from date of shipment each instrument manufactured by it to be free from defects in material and workmanship. Its liability under this warranty is limited to servicing or adjusting any instrument returned by the original purchaser to the factory for that purpose and to replace any defective parts therein.

ADDENDUM

This will replace DETAIL DESCRIPTION located on pages 12, 13 and 14.

DETAIL DESCRIPTION: The input signal from the module is applied to Pin 22 on the amplifier connector, through R4 to an integrated circuit chopper, IC1. The rebalance feedback signal is applied to the chopper vis Pin 16 and R1. This feedback signal originates at the rebalance potentiometer (driven mechanically by the servo system), and prior to scaling appears at Pin 10. Loading of the rebalance pot is eliminated by use of a high input impedance buffer amplifier (1/2 IC4). A divider network composed of R31 through R36 attenuates the rebalance signal to a level of 1 mv change for each 1 inch (or 2 cm) increment of pen movement. The output of this divider appears at Pin 15, and is further divided and loaded by two external resistors. English calibration (1 mv/in) is obtained by connecting Pin 16 to point A; metric calibration (0.5 mv/cm) is obtained by connecting Pin 16 to point B. Pin 11 is connected to a junction (point C) higher in the divider string, and is used for external variable attenuation. Capacitors C16 and C20 provide electrical damping of the servo response. Resistor R34 is the summing resistor for the Zero pot.

The input and rebalance signals are compared and modulated by IC1, a DPDT chopper, producing two square wave error signals. These two signals are differentially amplified by a preamplifier composed of C4–7, R5–9, R24, Q1 and IC3.

The output of this preamplifier appears at Pin 6 of IC3. The A.C. gain is controlled by feedback which travels through an external divider via Pin 6 (point E) and Pin 13 (point F) and then through R9 to the non–inverting input of IC3. The gain is determined approximately by the product of the ratio of the external divider and the ratio of R9 to R8. The external divider provides external gain control which is required for various control functions in the input modules.

The output of the preamplifier passes through C8 and the internal gain control, R38, to the input of a full wave demodulator composed of 1/3 IC2, R16–18, and R39. IC2 is composed of 3 pairs of complementary MOS FET's (C–MOS). One of these pairs is connected in such a way as to alternately connect the amplified error signal to first one and then the other input of a differential amplifier, 1/2 IC4. This yields two signals, each displaying only one–half of each cycle of error signal. These two outputs are summed algebraically and amplified by IC4. The result is a full wave demodulated representation of the error signal, which is now a D.C. signal.

The new D.C. error signal is buffered by a complementary Darlington configuration composed of Q2 and Q3. The output of the power stage is applied directly to the servo motor and to a non–linear feedback network composed of R22, R23, R25, R26, C14, CR5, and CR6. The purpose of this network is (1), to control the gain of the amplifier – demodulator section so that on part of the total servo is operating "open–loop" or without feedback stabilization of temperature, voltage and aging effects and (2), to provide the "dead zone compensation" mentioned in the general description. The transfer characteristics of this network are such that the incremental gain of the servo amplifier is highest at null, and therefore static errors due to dead zone are reduced or eliminated.

A power protection circuit is provided to limit dissipation in the servo motor. This circuit is composed of Q4, Q5, CR7, CR8, R27–30, and C15. The purpose of this circuit is to reduce the voltage applied to the servo motor after the pen has been driven against the mechanical stops for more than a few seconds. With zero volts present at the output of IC4 (and therefore at the motor), then neither Q4 or Q5 is turned on. If the output of IC4 swings to approximately ±6VDC or more, the voltage at the base of Q4 will gradually rise (at a rate determined by R29 and C15) to about 0.5VDC which causes Q4 to sink current through CR7 and R30 thus reducing the voltage at the bases of Q2 and Q3. Q5 conducts similarly for negative output voltage.

The chopper and demodulator are driven by an oscillator composed of 2/3 IC2, R10, R11, and C9. This is a common astable multi–vibrator whose frequency (approximately 1kh) is determined by the time constant of R10 and C9. In addition to driving the chopper and demodulator, the oscillator output is connected to a network composed of R2, R3, R37, and C3 which is adjusted to cancel the offset current generated by the chopper.

The reference supplies for the rebalance and zero voltages are derived from CR1 and CR2, which are highly stable temperature compensated zener diodes. CR3 and CR4 provide regulation of the bias supplies needed to operate IC1, IC2, and IC3. The operating current for these regulators is supplied by the 15 volt supplies located on the power supply board.

houston instrument | DIVISION OF BAUSCH & LOMB
4950 TERMINAL AVENUE, BELLAIRE, TEXAS 77401

MODULE

INSTRUCTION MANUAL

Series 2000, 3000, 4000 Recorders

MODULES

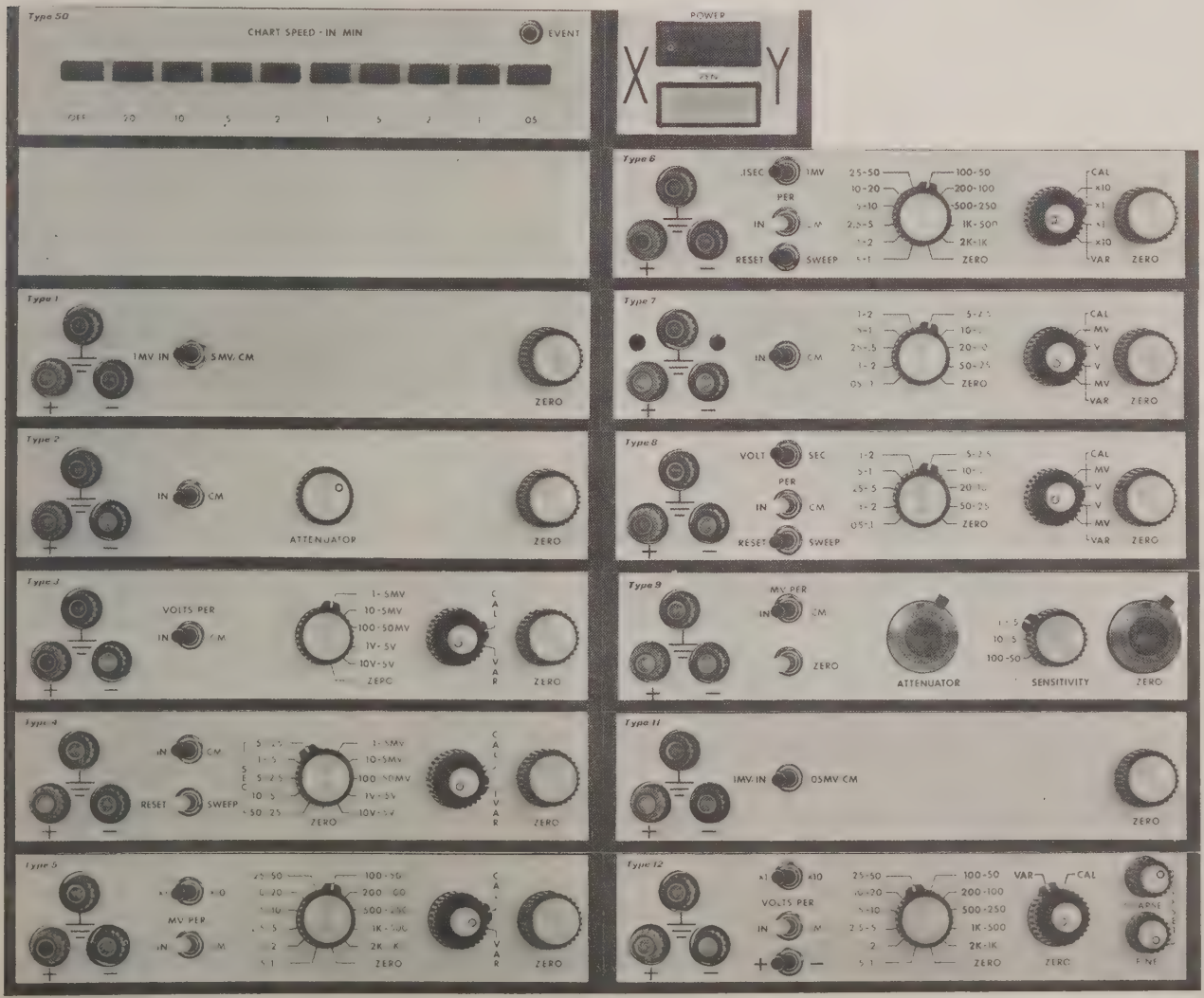
Three basic categories are offered — Control, Input and Drive.

The Control module is essential to all applications where modules of any category or type are used. Herein is incorporated the elementary manual control of instrument power and the electric pen lift. Approximately one-third the width of the other two categories, this module fits between X and Y modules, regardless of recorder series or function. It is truly compatible with all recorders.

Input modules are offered in many Types, to perform attenuation, bias, etc. of an input signal. In the 2000 Series of X–Y's, they are interchangeable between X and Y axes without modification. In the Series 3000 Strip and 4000 T–Y's, Input Types are only used for the Y axis, which is the independent variable. In all cases, the modules are identical and can be used between series of recorders for input analog variables.

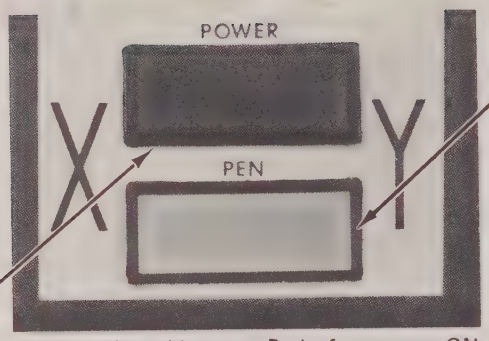
Drive modules furnish on/off action of the time drives for 3000 and 4000 recorders. They may also include selections for recorder multiple speed drives. In that there are no input terminals, their use is visually apparent.

Input and drive module inter-relationship with the recorder mainframe is described on the inside of this manual section. Tucked into the folder are separate inserts describing each module received with the recorder. As additional modules are secured, individual inserts will be supplied and should be inserted.



Serial Number_____

TYPE 100, 200 and 300 CONTROL MODULE

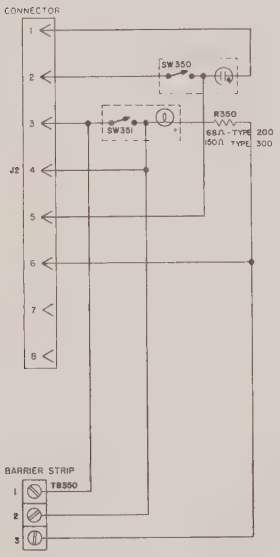


POWER: Illuminated pushbutton. Push for power ON. Push for power OFF. Lights when power is applied.

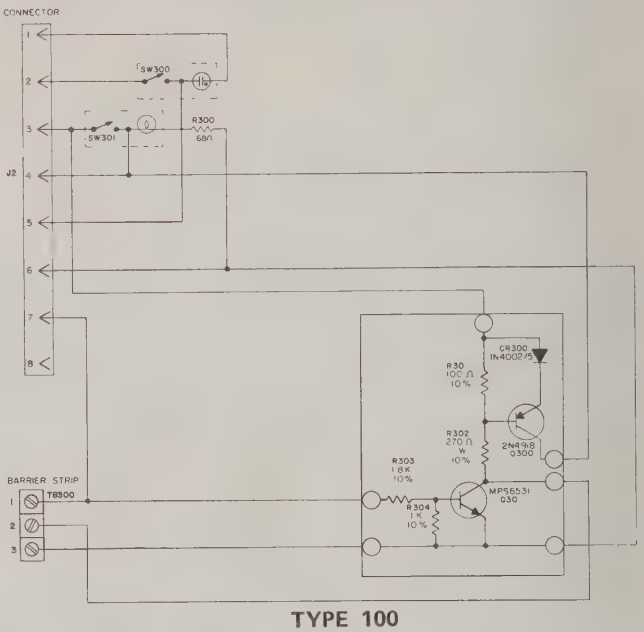
PEN: Illuminated pushbutton. Push for pen down. Push for pen up. Lights when pen is down.

For remote operation of type 200 place pen switch in UP position. Connect SPST contacts across terminals 1 and 2. The remote pen action must be capable of carrying an inductive load of +12 volts, with a steady state of 500 ma. Pushbutton lights as remote pen down is actuated.

Type 100 incorporates circuitry to allow logic level control of pen action. A positive voltage of 3 to 20 volts will drop pen. (Approximately 2K ohm load.)



TYPE 200 & 300



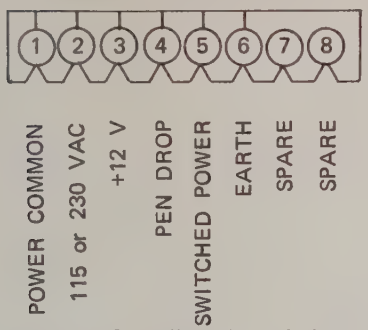
TYPE 100

PARTS LIST TYPE 100, 200 & 300

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
	2000–27	1	Chassis	Houston Instrument
	2000–125	1	Case	Houston Instrument
	2000–233	1	Front Panel	Houston Instrument
	2000–4	2	Alignment Post	Houston Instrument
J2	MC–836	1	Connector	Amphenol 26–4100–8P
TB350/300	MB–92	1	Terminal Board	Cinch Jones 3–172
R350	MR–77	1	Resistor - 68 ohm - ½W - 10% - Comp. (Type 200)	Allen Bradley
R350	MR–132	1	Resistor - 150 ohm - ½W - 10% - comp. (Type 300)	Allen Bradley
SW350/300	MS–348	1	Switch - SPDT - White Button	Molex 1820
SW351/301	MS–347	1	Switch - SPDT - Red Button	Molex 1820
			The following parts are for Type 100 only	
	2000–362	1	Pen lift Board	Houston Instrument
	2000–365	1	Chassis	Houston Instrument
	MS–90	2	Spacers	Smith 2100
CR300	MD–25	1	Diode IN4005	Motorola
R300	MR–77	1	Resistor - 68 ohm - ½W - 10% - Comp.	Allen Bradley
R301	MR–996	1	Resistor - 100 ohm - ¼W - 10% - Comp.	Allen Bradley
R302	MR–1033	1	Resistor - 270 ohm - 1W - 10% - Comp.	Allen Bradley
R303	MR–816	1	Resistor - 1.8K - ¼W - 10% - Comp.	Allen Bradley
R304	MR–111	1	Resistor - 1K - ¼W - 10% - Comp.	Allen Bradley
Q300	MQ–46	1	Transistor - 2N4918	Motorola
Q301	MQ–28	1	Transistor - MPS6531	Motorola

INTER–RELATIONSHIP RECORDER MAINFRAMES & MODULES

CONTROL CONNECTOR

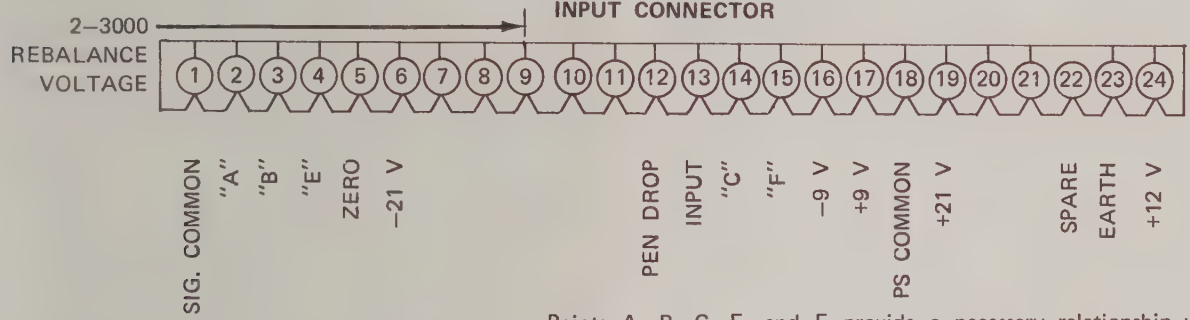


Center connector for all series of Recorders (2000, 3000, 3090, 4000, 4090). Pen Drop power is +12 which is wired in parallel to the adjacent modules. Therefore pen circuit can be activated elsewhere and will cause the module light to indicate.

Some modules work with all mainframes – others with just certain axis. (See page 1 of this manual section.) The following information shows the various mainframes and indicates the types of modules applicable. This information is redundant to that contained in a particular mainframe manual – yet it should show the difference between mainframes. Equally it should give a more complete grasp of the wide capabilities for use with standard module, or modified units or even module-less operation.

Note that the control module location having only 8 pins can serve only one purpose. In the type 2000 both X and Y axes are identical to accept input modules at random. In the type 3000 and 4000 recorders the 24 pin X axis connector is physically reversed from that of the Y axis. This insures that input and drive modules can only be connected in their proper locations.

INPUT CONNECTOR

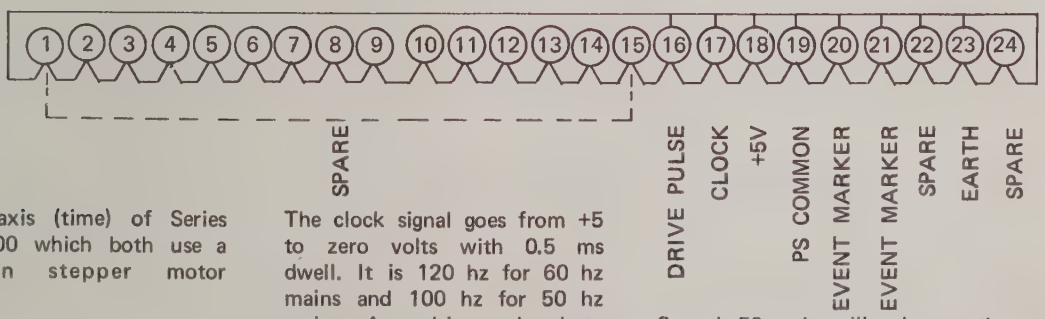


Do not use tie points 7, 20 and 21 for external connections.

Used on X and Y axis of Series 2000. Y axis only of 3000, 3090, 4000, and 4090.

Points A, B, C, E, and F provide a necessary relationship with the amplifier/module interplay for gain ratios and calibration. The zero is generated by a resistance across the +9 volt and –9 volt supplies (these are not available for any other purpose.) The + and –21 volt can provide up to 100 ma through the power supply common. The pen drop should be tied to +12 volt for action at this connector.

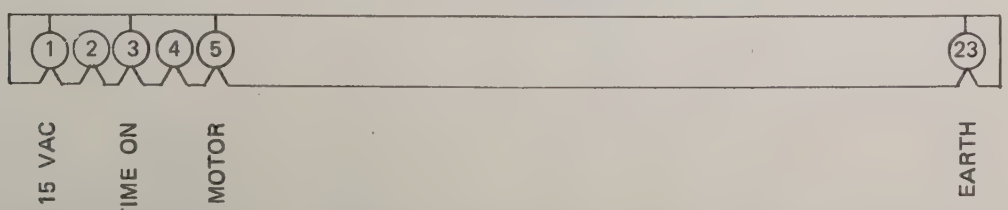
DRIVE CONNECTOR



Used on X axis (time) of Series 3000 and 4000 which both use a pulse driven stepper motor transport.

The clock signal goes from +5 to zero volts with 0.5 ms dwell. It is 120 hz for 60 hz mains and 100 hz for 50 hz mains. Any drive pulse between 3 and 50 volt will advance the stepper motor one step per actuation. The +5 volt is not to be used for external logic circuits. Event marker contact closure activates the event marker on Series 3000 units or starts a sweep on the Series 4000 recorders.

DRIVE CONNECTOR



Used on X axis (time) of Series 3090 and 4090 which both use a synchronous motor fixed speed transport.

Sweep is activated by a contact closure (¼ amp inductive, 115 volt) between Pins 1 and 3. Pin 3 can act as a common return for an indicator light. 115 VAC appears regardless of 115 or 230 VAC mains.

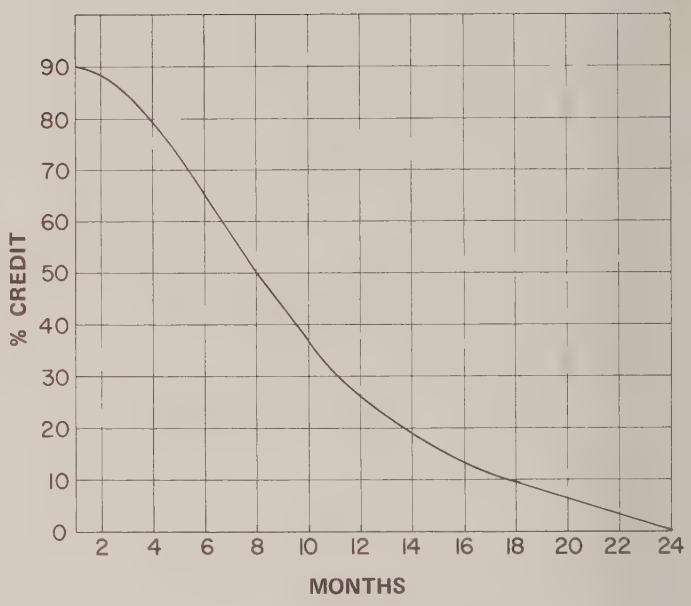
TRADE IN POLICY

Inevitably, a new need is found for the recorder. And very possibly a different module best suits the new application. In study of the modules, one notes that each offers somewhat more than the predecessor. Effectively, a new module could obsolete the old unit. Houston abhors the shelves full of dust gathering modules created by some instruments. Only the most flexible units are desired — the others sit. Our wide selection of modules could create an identical situation.

A simple trade-in policy banishes this ill. Credit against a new module purchase is allowed on the old unit. Credit is proportionate to age — not use, other than normal wear and tear.

So purchase originally only that needed. Then later upgrade at a minimal premium. And never put one aside — trade it in.

Refer to the chart to determine the trade-in value versus time.



MODULE TRADE IN CREDIT

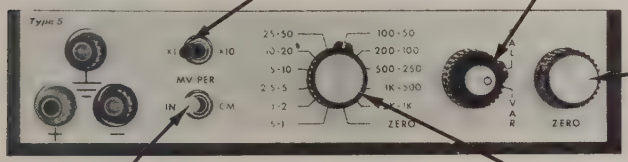
NOTES:

IMM 272
LITHO USA

TYPE 5
INPUT MODULE
DC ATTENUATOR

INPUT RESISTANCE: 1 megohm. Offers a constant resistance independent of source changes and recorder null, slewing or offscale condition.

MULTIPLIER: Two position toggle with x1 and x10 positions, directly affecting the attenuator sensitivities. It is ideal for initial set up and rough scaling plus the inevitable over range condition.



IN/CM: Allows ideal scaling flexibility making the recorder independent of the two types of conventional grids (inches or centimeters).

CIRCUIT DESCRIPTION: The input signal is fed to SW-677. In x1 position the signal is applied directly to the 12 position combination attenuator/switch. In the x10 position R-676 is placed in series with the attenuator while R-681 and R-680 act in parallel to provide a trim adjustment for a precise 10:1 ratio. The attenuator/switch is a specially designed unit incorporating deposited resistance contacts. This provides extremely precise division ratios with identical temperature coefficients. The ultimate result is a divider circuit with almost no between range error and extremely long term stability.

SW-676 and resistors R-684 and R-683 act as a switchable, but fixed voltage divider for the choice of 1 mv/inch or 0.5 mv/cm sensitivity. When SW-675 is in the CAL position resistors R-678 and R-679 act in conjunction with their adjacent 10K pot to set the amplifier open loop gain. In the VAR mode calibration is determined by R-682 and R-677 and the incremental resistance of their adjacent 10K pot. The open loop gain is varied correspondingly in the mating section. R-675 is used with the +9 and −9 reference voltage as a zero control.

CAL/VAR–VERNIER: A concentric control. Setting the bottom knob to CALibrate fixes the sensitivity according to the attenuator position. In VARiable, the top vernier knob allows between range sensitivity setting. Turning CW decreases sensitivity. At the extreme positions, sensitivity is equivalent to highest attenuator sensitivity setting or to somewhat less than the next lower attenuator setting, i.e., complete range overlap.

ZERO: Ten turn control of pen origin. ±110% adjustment is independent of sensitivity setting. Friction drag prevents inadvertent movement.

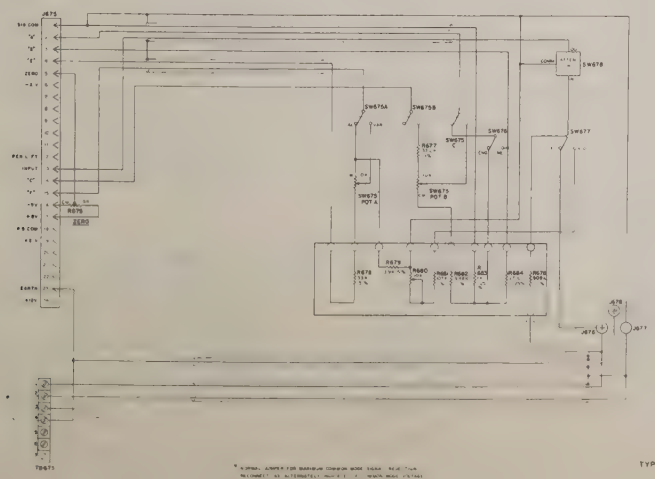
ATTENUATOR: Eleven position switch with sensitivity color coded for both inches and centimeters. Calibration is direct and precise. Both the multiplier and IN/CM switches have direct influence and therefore should always be considered.

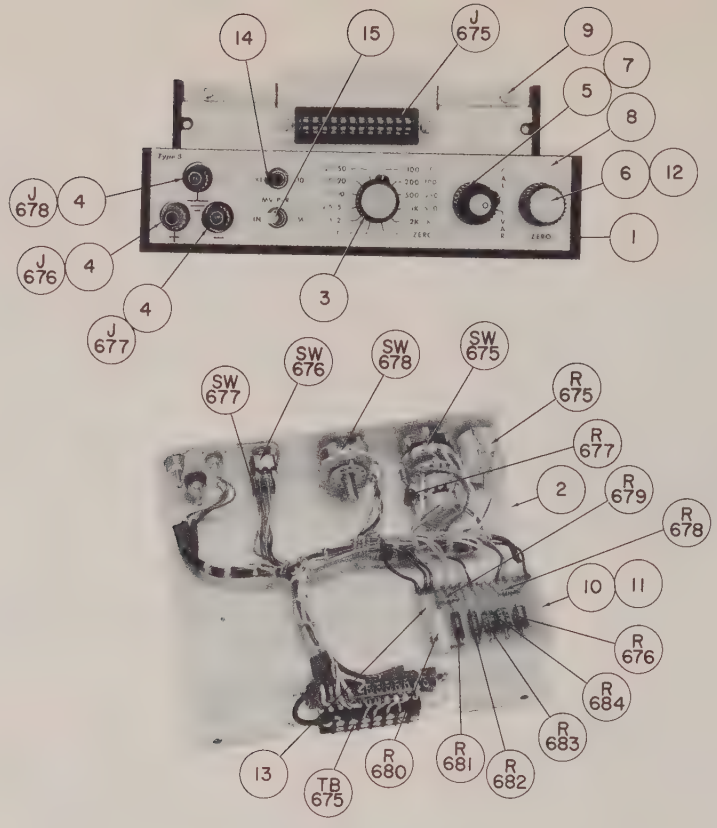
ZERO CHECK: A "twelfth" position of the attenuator switch. This setting places a short across the recorder's input without disturbing the input signal. The pen then progresses to an "electrical" zero position. This excursion represents the amount of base offset inherent in the input variable. Direct calibration is possible by the product of Δ D (chart distance moved) x Sensitivity x Multiplier.

INPUT CHARACTERISTICS: Differential and floating up to ±500 VDC or peak AC from ground.

COMMON MODE: For maximum rejection module chassis is connected to signal minus at rear terminal strip. Should hazardous common mode voltage levels be present reconnect jumper from chassis to earth ground as shown in accompanying schematic.

OTHER CHARACTERISTICS: Accuracy, CMR, Reference, Environmental, etc., are equivalent to the recorder mainframe specifications to which this module offers no degradation.



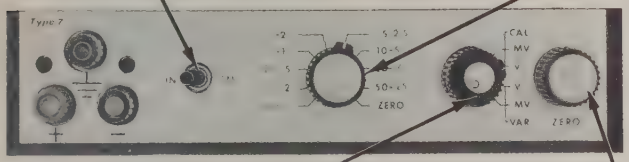


PARTS LIST TYPE 5

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
1	2000–130	1	Case Moulding - Machined	Houston Instrument
2	2000–319	1	Chassis - Machined	Houston Instrument
3	MK–4	1	Knob - Black	Buckeye PS-70PL-2
4	2000–374	3	Insulator - Binding Post	Houston Instrument
5	MK–30	1	Knob - Black	Buckeye PS-50D-1
6	MK–3	1	Knob - Black	Buckeye PS-70D-2
7	MK–29	1	Knob - Black	Buckeye PS-70CPL-2
8	2000–239	1	Decal - Front Panel	Houston Instrument
9	2000–4	2	Alignment Post - Module	Houston Instrument
10	2000–283	1	P. C. Board - Assembly	Houston Instrument
11	2000–284	1	P. C. Board - Drilled	Houston Instrument
12	95–356	1	Shaft Lock	Houston Instrument
13	MS–90	2	Spacer ¼ O. D. x ¼ Long - 6 Clearance	Smith 2100
14	MK–31	1	Knob - Black	Alco C-10
15	MK–32	1	Knob - White	Alco C-10
J675	MC–835	1	Connector	Amphenol 26-4100-24P
J676	MB–94	1	Binding Post - Red	Superior DF-21-RC
J677	MB–95	1	Binding Post - Black	Superior DF-21-BC
J678	MB–96	1	Binding Post - Green	Superior DF-21-GNC
R675	MP–385	1	Pot - 5K	Duncan 3253-5K
R676	MR–1072	1	Resistor - 909K - 1% - ½W - MF	Texas Instrument
R677	MR–571	1	Resistor - 33.2K - 1% - ½W - MF	Texas Instrument
R678	MR–481	1	Resistor - 33K - 5% - 1/3W - CF	Mepco/Electra
R679	MR–842	1	Resistor - 3.9K - 5% - 1/3W - CF	Mepco/Electra
R680	MP–380	1	Pot - 10K	Beckman 77PR10K
R681	MR–1073	1	Resistor - 107K - 1% - ½W - MF	Texas Instrument
R682	MR–986	1	Resistor - 3.48K - 1% - ½W - MF	Texas Instrument
R683	MR–1006	1	Resistor - 1K - .025% - ¼W - WW	Gamble
R684	MR–1005	1	Resistor - 270 ohm - 0.1% - ¼W - WW	Gamble
SW675	MS–355	1	Switch - W/Pot Assembly	CTS 2212
SW676	MS–351	2	Switch - SPDT	ALCO MST-105-D
SW677			Same As SW676	
SW678	MS–363	1	Switch	Helipot 1390-35-0
TB675	MB–109	1	Barrier Strip	Cinch Jones 7-172

TYPE 7
INPUT MODULE
DC PRE–AMPLIFIER

IN/CM: Allows ideal scaling flexibility making the recorder independent of the two types of conventional grids (inches or centimeters).



MULTIPLIER/VERNIER: A concentric control. The bottom switch selects either millivolts or volt ranges of the corresponding attenuator switch. The top two positions are CALibrated selections which establish the sensitivity at that of the attenuator. The bottom two VARiable positions allow between range setting to be made with the top position knob. Turning CW decreases sensitivity from that of the attenuator setting to something less than the next lower attenuator sensitivity setting.

INPUT RESISTANCE: Potentiometric on all mv ranges. On volt ranges — 1 megohm.

INPUT CHARACTERISTICS: Differential and floating up to ±500 VDC or peak A.C. from ground.

ATTENUATOR: Nine position switch with sensitivity color coded for inches and centimeters. Calibration is direct and precise. Both the Multiplier/Vernier and IN/CM switches have a direct influence and therefore should always be considered. Maximum input voltage 200 volts.

ZERO CHECK: A "tenth" position of the attenuator switch. This setting internally disconnects the input and places a short across the recorder's input. The pen then progresses to an "electrical" zero position. This excursion represents the amount of base offset inherent in the input variable. Direct calibration is possible by the product of Δ D (chart distance moved) x sensitivity x multiplier.

ZERO: Ten turn control of pen origin. ±100% adjustment is independent of sensitivity setting. Friction drag prevents inadvertent movement.

COMMON MODE: For maximum rejection module chassis is connected to signal minus at rear terminal strip. Should hazardous common mode voltage levels be present reconnect jumper from chassis to earth ground as shown in accompanying schematic.

CIRCUIT DESCRIPTION

The input signal is fed to one section of the CAL–VAR–VOLT–MV switch, SW-752D. In both MV positions the signal is fed through SW-752C to point L on the preamp board, through R-760, out point K to point J which is the input side of an integrated circuit chopper, IC-850.

The D.C. input signal is now applied to Pin 3 of the chopper and compared to a feedback reference signal at Pin 8. The difference signal is modulated by the chopper to generate an A.C. square wave signal. This signal passes through R-767 and C-752 to the gate of FET Q-750, the input termination of a high input impedance preamplifier composed of Q-750, Q-751, Q-752, IC-751 and associated components.

The A.C. gain of the preamplifier is controlled by negative feedback through the divider R-787 — R-786, and is set at a value of 1000.

The amplified error signal passes through C-755 to a full-wave, synchronous demodulator composed of R-790, R-791, Q-755, Q-756, These two FET's act as shunting choppers, and are turned on during opposite half cycles. The result is two half wave demodulated waveforms of opposite polarity. These two signals are summed and filtered by a differential integrator composed of R-792, R-793, C-764, C-765 and IC-852.

The drive signals that activate the input and demodulator choppers are generated by a flip-flop, Q-753 — Q-754, which is triggered by a unijunction transistor relaxation oscillator, Q-762. The two output signals are fed directly to the gates of the demodulator transistors, and through two phase shifting networks, R-778 — C-758 and R-779 — R-782 — C-759. R-779 acts as a balance control which allows the input offset current to be set to zero.

Q-757, Q-758 and CR-752 form a series regulator that provides +15 volts D.C. to the module. Q-768 provides constant current to CR-762, independent of variations in the +21 volt unregulated source. Q-760 and Q-761 similarly regulate the −15 volt D.C. rails, both using CR-753 and Q-760 as a reference.

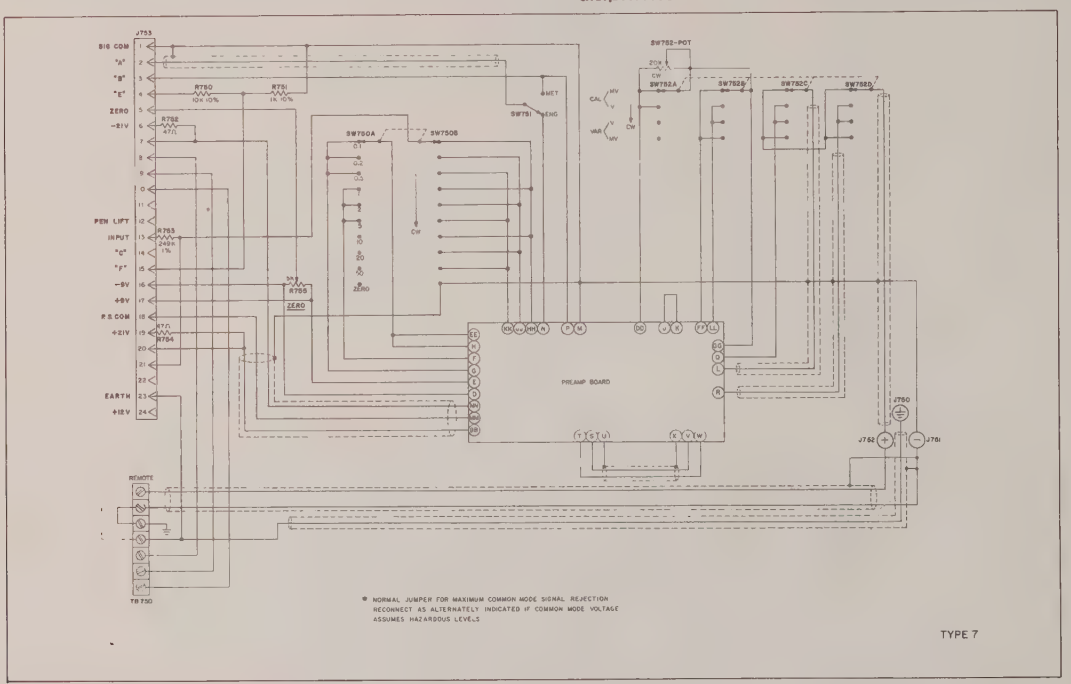
The output of the preamp leaves the board at point DD, through either SW-752A (CAL position) or SW-752-Potentiometer (VARiable positions), back to point GG on the board, and to the wiper of

SW-752B. In the MV positions the output signal passes on to point FF. Connecting point FF to the output and to point GG (as performed by SW-752B) applies the output voltage to R-797, which is the top of an output divider (R-798, R-799, R-800). Disconnecting point FF inserts R-805 in series with the divider, which attenuates the output of the divider by a factor of 10. This attenuation completes the conversion from MV to Volt calibration in conjunction with the input attenuator.

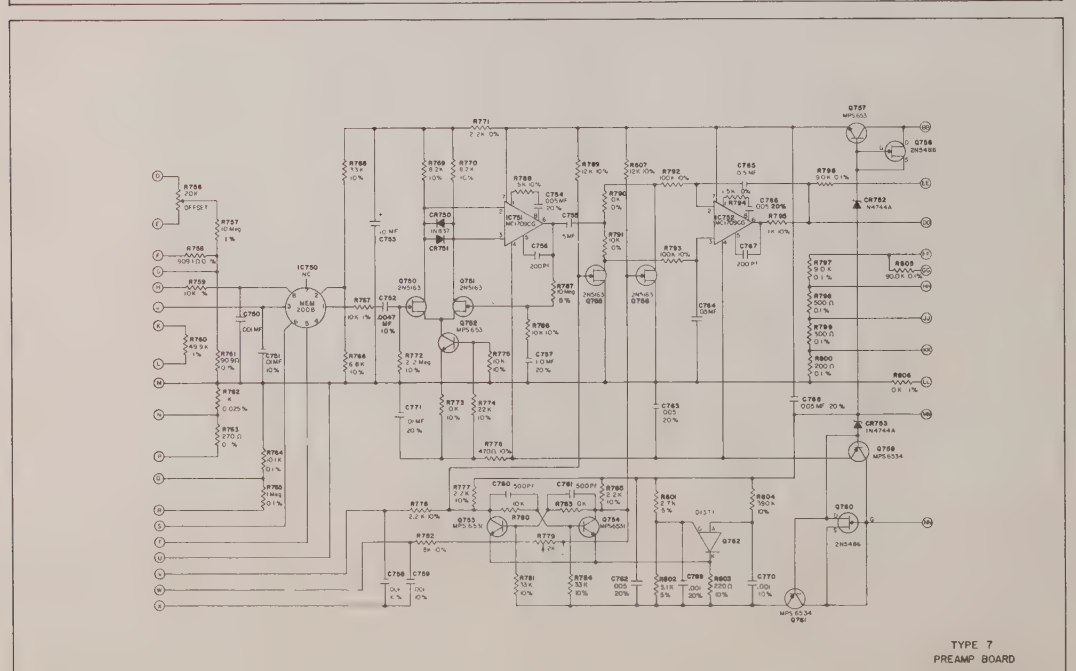
Note that point LL is connected to the output of the preamp when R-805 is in series with the divider. This connects R-806 in parallel with the output of SW-752A, which maintains a constant input resistance to the divider. The purpose served here is to allow the VAR pot, SW-752, to effectively attenuate the input to the divider in both Volt and MV positions of SW-752.

The output of the preamp also is connected to R-796, which is the upper leg of a feedback divider network. The lower end of the resistor is connected to point EE and out to SW-750A and point H SW-854A. SW-750A selects one of three values of resistance, 90.9 ohm, 1000 ohm or open circuit, for the bottom leg of the feedback divider corresponding to values of preamp gain of 100, 10 and 1 respectively. This feedback point is connected to point H, which is connected to the reference input of the chopper, IC-750, through R-759. SW-750A and SW-750B select the combinations of gain and output divider settings to produce the various module sensitivities.

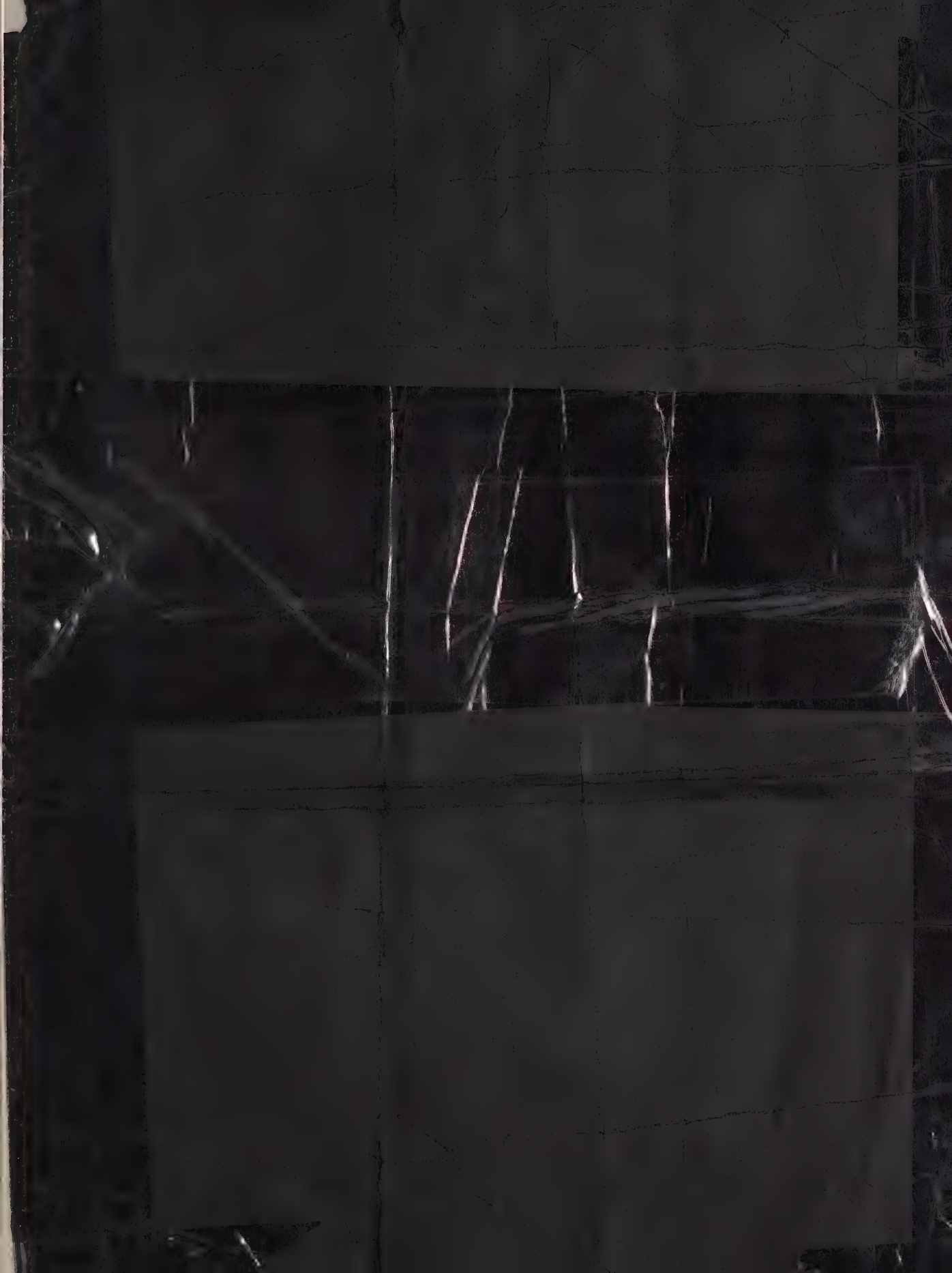
SW-751 and resistor R-762 and R-763 a switchable voltage divider for the choice of 0.1 mv/inch or .05 mv/cm maximum sensitivity. This change in sensitivity is effected in the mainframe servo amplifier, with R-850 and R-751 setting the gain range of the servo amplifier.

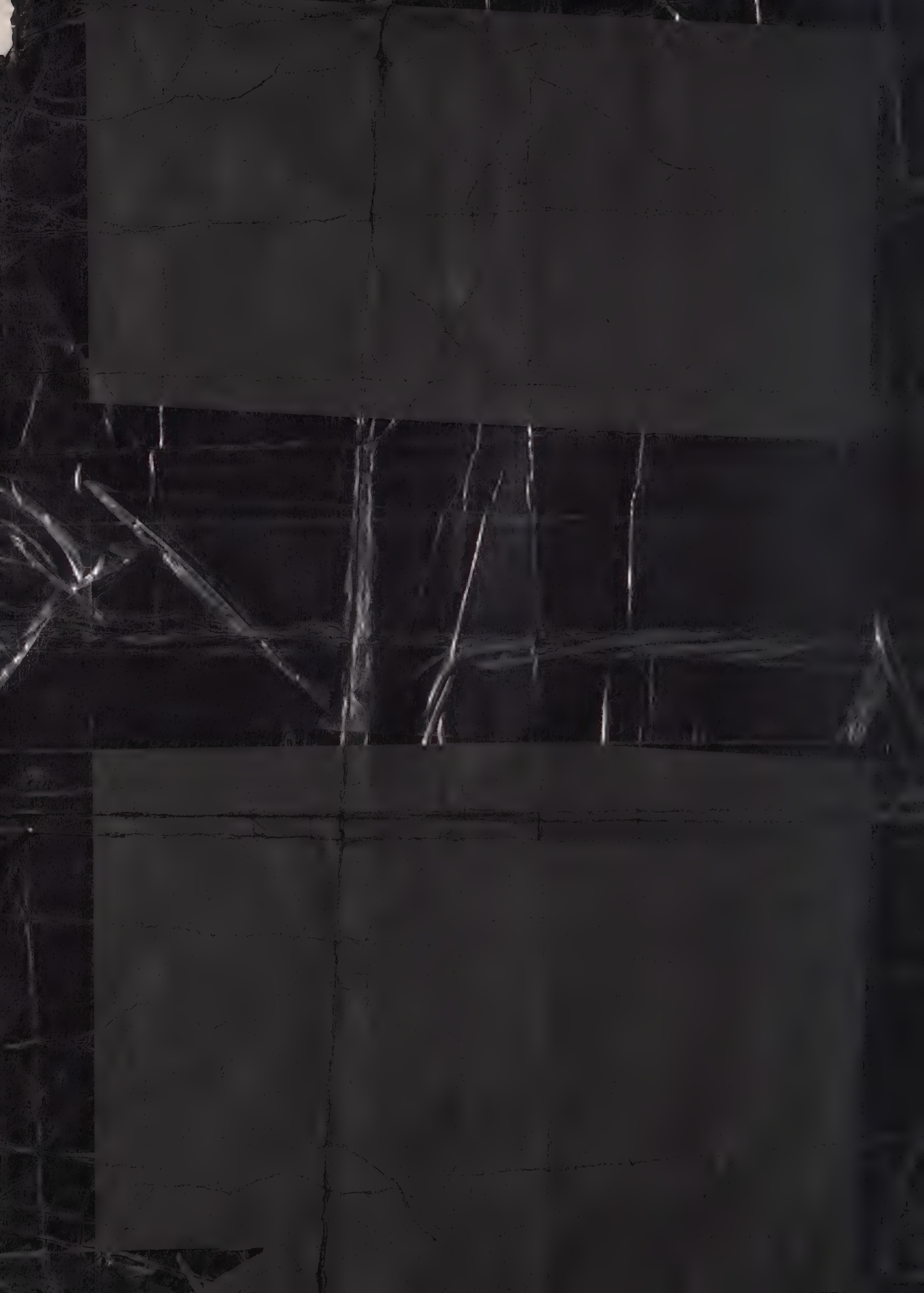


TYPE 7



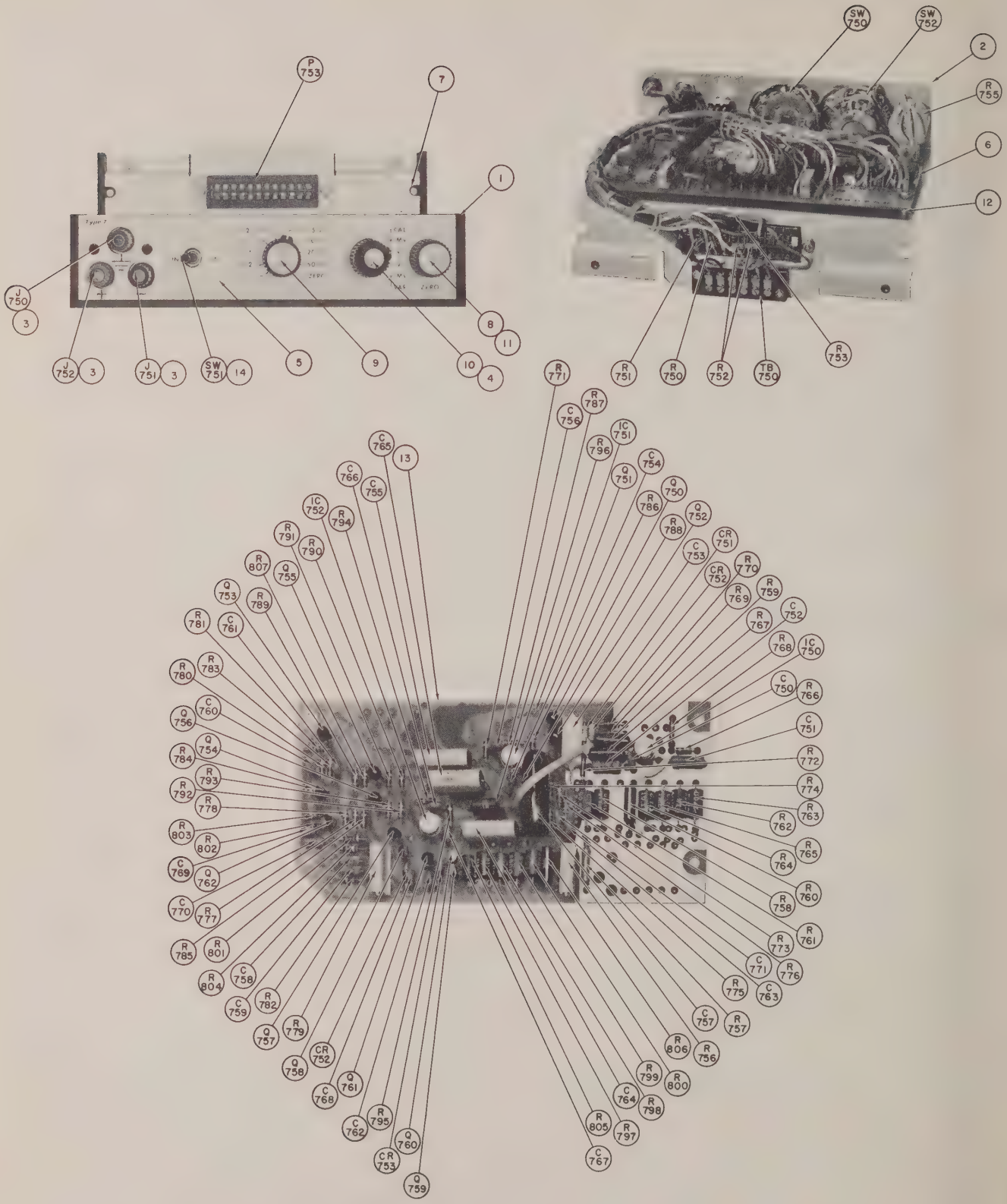
TYPE 7
PREAMP BOARD





PARTS LIST TYPE 7

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
1	2000--227	1	Case Moulding Machined	Houston Instrument
2	2000--321	1	Chassis Machined	Houston Instrument
3	2000--374	3	Insulator - Binding Post	Houston Instrument
4	MK--29	1	Knob - Black	Buckeye PS-70CPL-2
5	2000--241	1	Decal - Front Panel	Houston Instrument
6	2000--301	1	Pre-Amp Board Assembled	Houston Instrument
7	2000--4	1	Alignment Post	Houston Instrument
8	95--356	1	Shaft Lock	Houston Instrument
9	MK--4	1	Knob - Black	Buckeye PS-70PL-2
10	MK--30	1	Knob - Black	Buckeye PS-50D-1
11	MK--3	1	Knob - Black	Buckeye PS-70D-2
12	MS--90	4	Spacer	Smith 2100
13	2000--302	1	Pre-Amp Board Drilled	Houston Instrument
14	MK--31	1	Knob - Black	Alco C-10
J750	MB--96	1	Binding Post - Green	Superior DF-21-GNC
J751	MB--95	1	Binding Post - Black	Superior DF-21-BC
J752	MB--94	1	Binding Post - Red	Superior DF-21-RC
SW750	MS--366	1	Switch - 2 Pole - 10 Pos.	CTS SW-2306
SW751	MS--351	1	Switch - SPDT	ALCO MST105D
SW752	MS--362	1	Switch - W/Pot Ass'y 4 Pole - 4 Pos. - 20K	CTS SW-2265
P753	MC--835	1	Connector	Amphenol 26-4100-24P
TB750	MB--109	1	Barrier Strip	Cinch Jones 7-172
C750	MC--579	2	Capacitor - .001 MF - 20% - 1000V - Ceramic	Sprague Electronic
C751	MC--189	1	Capacitor - .01 MF - 10% - 200V - Mylar	Sprague Electronic
C752	MC--186	1	Capacitor - .0047 MF - 10% - 200V - Mylar	Sprague Electronic
C753	MC--542	1	Capacitor - 10 MF - 35V - MTA	Mallory Capacitor
C754	MC--545	5	Capacitor - .005 MF - 20% - 50V - Ceramic	Sterling Electronic
C755	MC--123	3	Capacitor - 0.5 MF - 5% - 200V - Mylar	Sprague Electronic
C756	MC--183	2	Capacitor - 200 PF - 20% - 1000V - Ceramic	Sprague Electronic
C757	MC--157	1	Capacitor - 1.0 MF - 20% - 200V - Mylar	Sprague Electronic
C758	MC--409	3	Capacitor - .001 MF 10% - 200V - Mylar	Sprague Electronic
C759			Same As C758	
C760	MC--468	2	Capacitor - 500 PF - 20% - 1000V - Ceramic	Sprague Electronic
C761			Same As C760	
C762			Same As C754	
C763			Same As C754	
C764			Same As C755	
C765			Same As C755	
C766			Same As C754	
C767			Same As C756	
C768			Same As C754	
C769			Same As C750	
C770			Same As C758	
C771	MC--229	1	Capacitor - .01 MF - 20% - 100V - Ceramic	Sprague Electronic
CR750	MD--8	2	Diode - 1N837	General Instrument
CR751			Same As CR750	
CR752	MD--19		Diode - 1N4744A	Motorola
CR753			Same As CR752	
IC750	MW--132	1	Intergrated Circuit	Gen. Inst. MEM 2008
IC751	MW--117	2	Intergrated Circuit	Motorola MC 1709CG
IC752			Same As IC751	
Q750	MQ--48	4	Transistor 2N5163	Motorola
Q751			Same As Q750	
Q752	MQ -28	4	Transistor 2N6531	Motorola
Q753			Same As Q752	
Q754			Same As Q752	
Q755			Same As Q750	
Q756			Same As Q750	
Q757			Same As Q752	
Q758	MQ--64	2	Transistor 2N5486	Motorola
Q759	MQ--29	2	Transistor MPS 6534	Motorola
Q760			Same As Q758	
Q761			Same As Q759	
Q762	MQ--44	1	Transitor D13T1	General Electric
R750	MR--114	8	Resistor - 10K - 10% - ¼W - Composition	Allen Bradley
R751	MR--111	1	Resistor - 1K - 10% - ¼W - Composition	Allen Bradley
R752	MR--840	2	Resistor - 47 Ohm - 10% - ¼W - Composition	Allen Bradley
R753	MR -260	1	Resistor - 249K - 1% - ½W - MF	Texas Instrument
R754			Same As R752	
R755	MP--385	1	Pot - 5K	Duncan 3253
R756	MP--118	1	Pot - 20K	Beckman 77PR20K
R757	MR--278	1	Resistor - 10 Meg - 1% - ½W - DC	Allen Bradley
R758	MR--1007	1	Resistor - 909.1 Ohm - .1% - ¼W - WW	Gamble
R759	MR--1036	2	Resistor - 10K - 1% - ¼W - MF	Texas Instrument
R760	MR--395	1	Resistor - 49.9K - 1% - ½W - MF	Texas Instrument
R761	MR -506	1	Resistor - 90.9K - 0.1% - ¼W - WW	Gamble
R762	MR--1006	1	Resistor - 1K - .025% - ¼W - WW	Gamble
R763	MR--1005	1	Resistor - 270 Ohm - 0.1% - ¼W - WW	Gamble
R764	MR--507	1	Resistor - 10.1K - 0.1% - ¼W - WW	Gamble
R765	MR--596	1	Resistor - 1 Meg - 0.1% - ¼W - WW	Gamble
R766	MR--137	1	Resistor 6.8K - 10% - ¼W - Composition	Allen Bradley
R767			Same As R759	
R768	MR--143	3	Resistor - 33K - 10% - ¼W - Composition	Allen Bradley
R769	MR--824	2	Resistor - 8.2K - 5% - ¼W - Composition	Allen Bradley
R770			Same As R769	
R771	MR--118	4	Resistor - 2.2K - 10% - ¼W - Composition	Allen Bradley
R772	MR--190	1	Resistor - 2.2 Meg - 10% - ¼W - Composition	Allen Bradley
R773			Same As R750	
R774	MR--115	1	Resistor - 22K - 10% - ¼W - Composition	Allen Bradley
R775			Same As R750	
R776	MR--128	1	Resistor - 470 Ohm - 10% - ¼W - Composition	Allen Bradley
R777			Same As R771	
R778			Same As R771	
R779	MP--107	1	Pot - 2K	Helitrim 77PR2K
R780			Same As R750	
R781			Same As R768	
R782	MR--816	1	Resistor - 1.8K - 10% - ¼W - Composition	Allen Bradley
R783			Same As R750	
R784			Same As R768	
R785			Same As R771	
R786			Same As R750	
R787	MR--965	1	Resistor - 10 Meg - 5% - ¼W - Composition	Allen Bradley
R788	MR--136	2	Resistor - 1.5K - 10% - ¼W - Composition	Allen Bradley
R789	MR--359	2	Resistor - 12 K - 10% - ¼W - Composition	Allen Bradley
R790			Same As R750	
R791			Same As R750	
R792	MR--117	2	Resistor - 100K - 10% - ¼W - Composition	Allen Bradley
R793			Same As R792	
R794			Same As R788	
R795	MR--111	1	Resistor - 1K - 10% - ¼W - Composition	Allen Bradley
R796	MR--534	2	Resistor - 9K - 0.1% - ¼W - Composition	Allen Bradley
R797			Same As R796	
R798	MR--508	1	Resistor - 500 Ohm - 0.1% - ¼W - WW	Gamble
R799	MR--509	1	Resistor - 300 Ohm - 0.1% - ¼W - WW	Gamble
R800	MR--531	1	Resistor - 200 Ohm - 0.1% - ¼W - WW	Gamble
R801	MR--482	1	Resistor - 2.7K - 5% - ¼W - Composition	Allen Bradley
R802	MR--1128	1	Resistor - 5.1K - 5% - ¼W - Composition	Allen Bradley
R803	MR--107	1	Resistor - 220 Ohm - 10% - ¼W - Composition	Allen Bradley
R804	MR--188	1	Resistor - 390K - 5% - ¼W - Composition	Allen Bradley
R805	MR--536	1	Resistor - 90K - 0.1% - ¼W - WW	Gamble
R806	MR--239	1	Resistor - 11K - 1% - ½W - MF	Texas Instrument
R807			Same As R789	


P 753
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1
J 750
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J 752
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J 751
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SW 751
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SW 752
2
R 755
6
12
R 753
R 751
R 750
R 752
TB 750
R 771
R 787
C 756
IC 751
R 796
C 754
Q 751
Q 750
R 786
Q 752
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R 769
R 759
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R 767
R 768
IC 750
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R 766
C 751
R 772
R 774
R 763
R 762
R 765
R 764
R 758
R 760
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C 763
C 757
R 757
R 806
R 756
R 799
R 800
C 764
R 798
R 805
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R 790
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R 789
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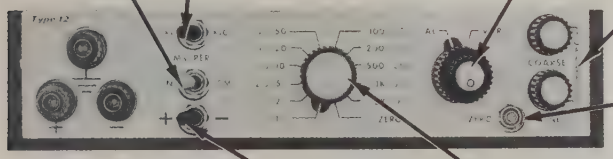
R 780
R 783
C 760
Q 756
Q 754
R 784
R 793
R 792
R 778
R 803
R 802
C 769
Q 762
C 770
R 777
R 785
R 801
C 758
R 804
C 759
R 782
Q 757
R 779
CR 752
Q 758
Q 761
C 768
C 762
R 795
Q 760
CR 753
Q 759

TYPE 12
INPUT MODULE
ATTENUATOR/OFFSET

IN/CM: Two position toggle allows ideal scaling flexibility making the recorder independent of the two types of conventional grids (inches or centimeters).

MULTIPLIER: Two position toggle with x1 and x10 positions, affecting directly the attenuator factors. It is ideal for initial set up and rough scaling plus the inevitable over range condition.



OFFSET POLARITY: Two position toggle sets the direction of suppression.

INPUT CHARACTERISTICS: Differential and floating up to ±500 VDC or peak AC from ground.

COMMON MODE: For maximum rejection module chassis is connected to signal minus at rear terminal strip. Should hazardous common mode voltage levels be present reconnect jumper from chassis to earth ground as shown in accompanying schematic.

OTHER CHARACTERISTICS: Accuracy, CMR, Reference, Environmental, etc., are equivalent to the recorder mainframe specifications to which this module offers no degradation.

CAL/VAR–VERNIER: A concentric control. Setting the bottom knob to CALibrate fixes the sensitivity according to the attenuator position. In VARiable, the top knob allows between range sensitivity setting. Turning CW decreases sensitivity. At the extreme positions, sensitivity is equivalent to highest attenuator sensitivity setting or to somewhat less than the next lower attenuator setting, i.e., complete range overlap.

OFFSET: Two ten turn controls give precise and stable voltages of 0–1 volt (coarse) and 0–10 mv (fine).

ZERO: Ten turn screwdriver adjustment pen origin. ±110% adjustment is independent of sensitivity setting.

ATTENUATOR: Eleven position switch with sensitivity color coded in both inch and centimeter units. Calibration is direct and precise. Both the multiplier and IN/CM switches have a direct influence and therefore should always be considered.

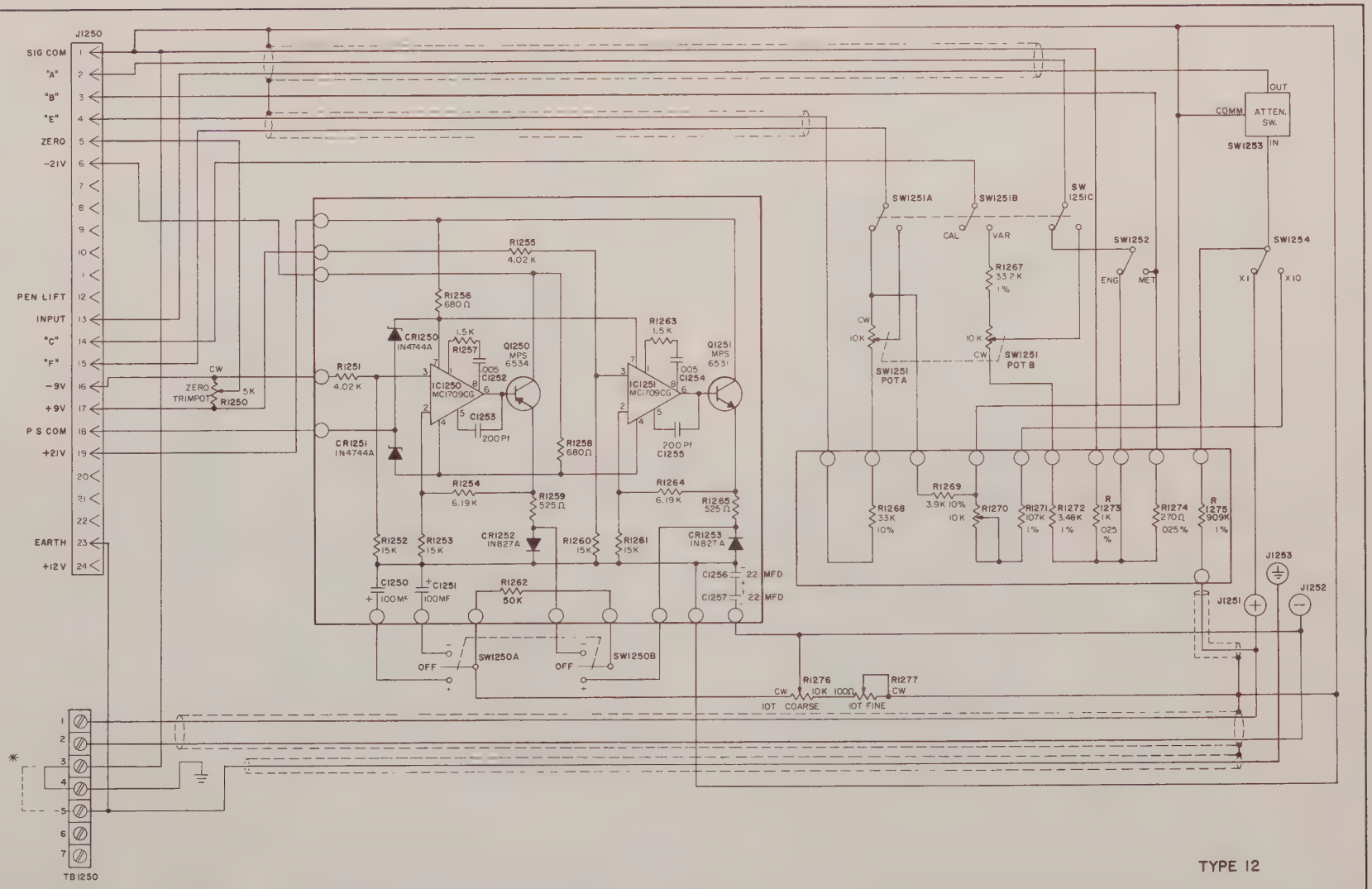
ZERO CHECK: A "twelfth" position of the attenuator switch. This setting places a short across the recorder's amplifier input without disturbing the input signal. The pen then progresses to an "electrical" zero position. This excursion represents the amount of base offset inherent in the input variable. Direct calibration is possible by the product of ΔD (chart distance moved) x Sensitivity X Multiplier.

INPUT RESISTANCE: 1 megohm. Offers a constant resistance independent of source changes and recorder null, slewing or offscale condition.

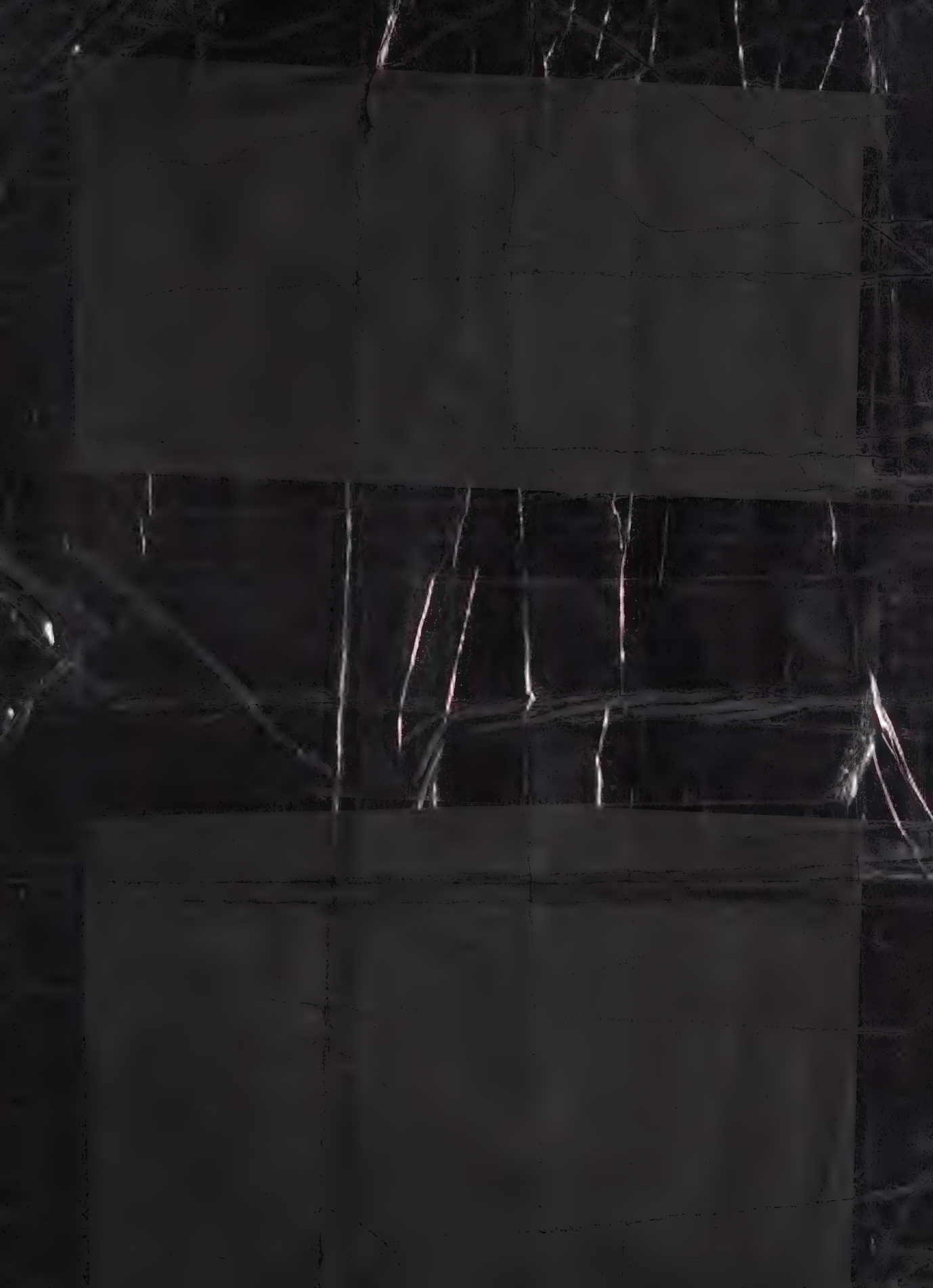
CIRCUIT DESCRIPTION: The input signal is fed to SW-1254. In x1 position the signal is applied directly to the 12 position combination attenuator/switch. In the x10 position R-1275 is placed in series with the attenuator while R-1271 and R-1270 act in parallel to provide a trim adjustment for a precise 10:1 ratio. The attenuator/switch is a specially designed unit incorporating deposited resistance contacts. This provides extremely precise division ratios with identical temperature coefficients. The ultimate result is a divider circuit with almost no between range error and extremely long term stability.

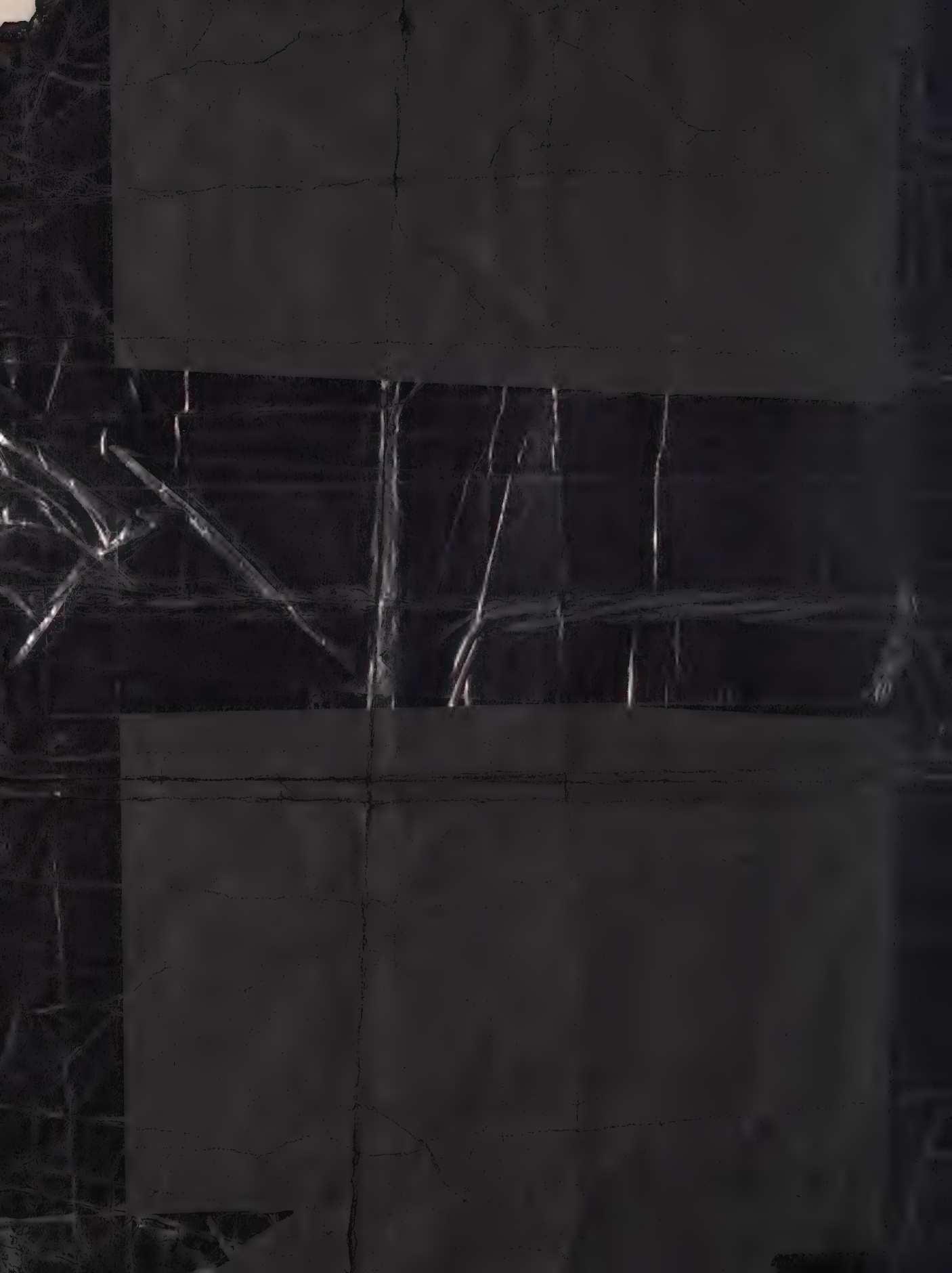
SW-1252 and resistors R-1274 and R-1273 act a switchable but fixed voltage divider for the choice of 1 mv/inch or 0.5 mv/cm sensitivity. When SW-1251 is in the CAL position resistors R-1268 and R-1269 act in conjunction with their adjacent 10K pot to set the amplifier open loop gian. In the VAR mode calibration is determined by R-1272 and R-1267 and the incremental resistance of their adjacent 10K pot. The open loop is varied correspondingly in the mating section. R-1250 is used with the +9 and –9 reference voltage as a zero control.

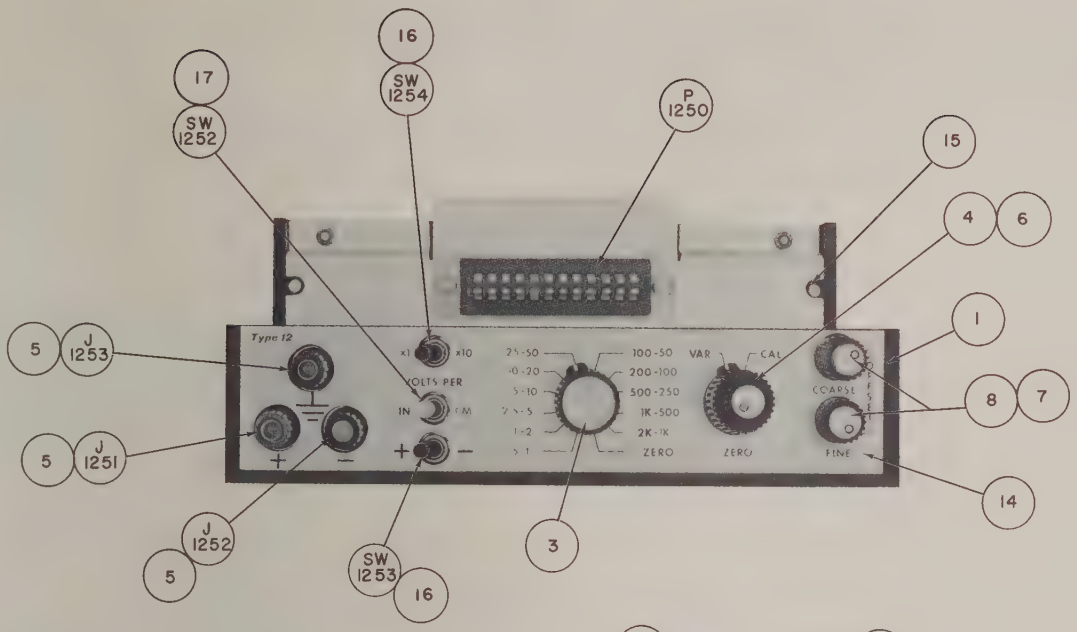
The offset voltage circuit originates at the +9 and –9 volt highly regulated reference supply which are fed via 4.02K current limiting resistors to complementary buffers composed of IC-1250, IC-1251, Q-1250 and Q-1251. Both IC's have extremely high input resistance while the ultimate output transistors have low outputs of 10 ohms. This yields buffered current sources at the 525 ohm resistors with a maximum total temperature span deviation of 0.1%. The very highly temperature compensated zener, IN827A futher reduces possible total temperature variation by 50 to 1. Capacitors C-1250 and C-1251 provide additional filtering. Capacitor C-1256 shunts any possible signal common mode voltage. Switch SW-1250 selects the proper offset voltage for adjustment at ten turn potentiometers R-1276 and R-1277.

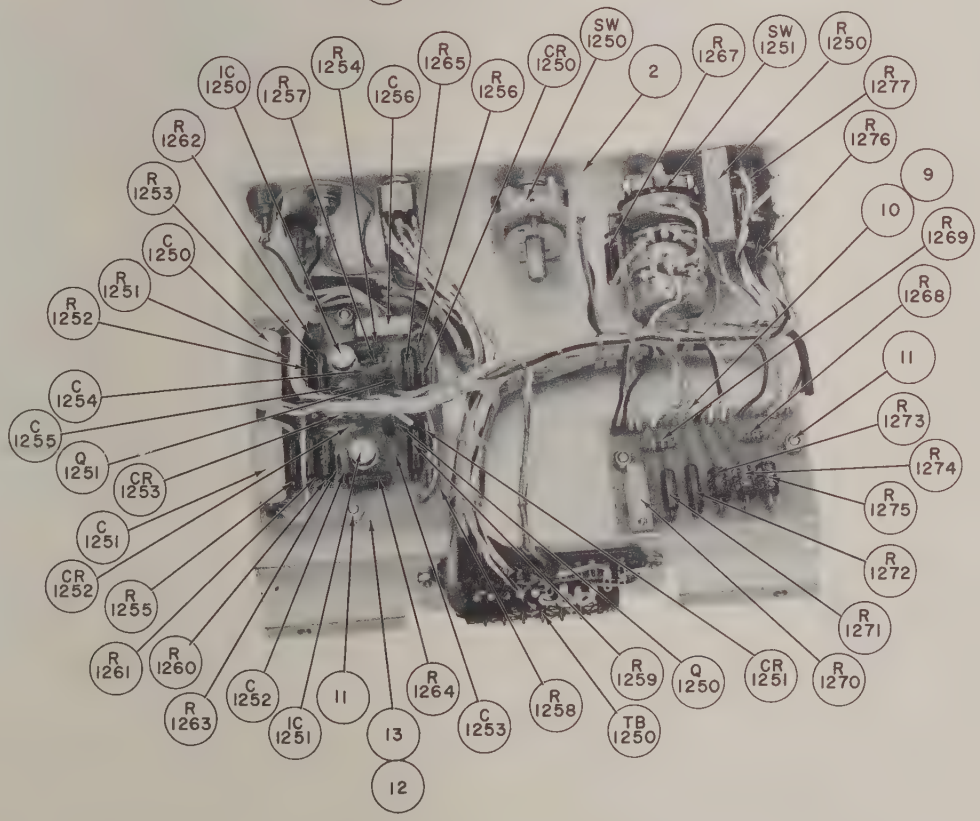


* NORMAL JUMPER FOR MAXIMUM COMMON MODE SIGNAL REJECTION. RECONNECT AS ALTERNATELY INDICATED IF COMMON MODE VOLTAGE ASSUMES HAZARDOUS LEVELS.









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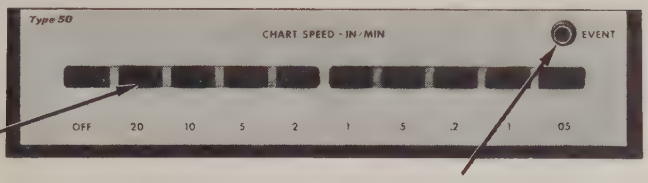
PARTS LIST TYPE 12

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
1	2000–229	1	Case Molding - Machined	Houston Instrument
2	2000–230	1	Chassis - Machined	Houston Instrument
3	MK–4	1	Knob - Black	Buckeye PS-70PL-2
4	MK–30	1	Knob - Black	Buckeye PS-70D-2
5	2000–374	3	Insulator - Binding Post	Houston Instrument
6	MK–29	1	Knob - Black	Buckeye PS-70CPL-2
7	MK–28	2	Knob - Offset - Black	Buckeye PS-50-3
8	2000–387	2	Bushing - Offset Knob	Houston Instrument
9	2000–283	1	P. C. Board - Assembly	Houston Instrument
10	2000–284	1	P. C. Board - Drilled	Houston Instrument
11	MS–90	4	Spacer ¼ OD x ¼ Long	Smith 2100
12	2000-390	1	P. C. Board - Assembly - Type 12	Houston Instrument
13	2000–389	1	P. C. Board - Drilled	Houston Instrument
14	2000–245	1	Decal - Front Panel	Houston Instrument
15	2000–4	2	Alignment Post - Modules	Houston Instrument
16	MK–31	2	Knob - Black	Alco C-10
17	MK–32	1	Knob - White	Alco C-10
C1250	MC–567	2	Capacitor - 100 MF - 15V - MTA100E15	Mallory Capacitor
C1251			Same As C1250	
C1252	MC–545	2	Capacitor - 5000 PF - 50V - Ceramic	Sprague Electronic
C1253	MC–183	2	Capacitor - 200 PF - 20% - 1000V - Ceramic	Sterling Electronic
C1254			Same As C1252	
C1255			Same As C1253	
C1256	MC–540	1	Capacitor - 22 MF - 10% - 15V - M. Mylar	TRW 935
C1257			Same As C1556	
CR1250	MD–19	2	Diode - 1N4744A	Motorola
CR1251			Same As CR1250	
CR1252	MD–94	2	Diode 1N827A	Motorola
CR1253			Same As CR1252	
P1250	MC–835	1	Connector	Amphenol 26-4100-24P
J1251	MB–94	1	Binding Post - Red	Superior DF-21-RC
J1252	MB–95	1	Binding Post - Black	Superior DF-21-BC
J1253	MB–96	1	Binding Post - Green	Superior DF-21-GNC
IC1250	MW–117	2	Intergrated Circuit MC-1709CG	Motorola
IC1251			Same As IC1250	
Q1250	MQ–29	1	Transistor - MPS6534	Motorola
Q1251	MQ–28	1	Transistor - MPS6531	Motorola
R1250	MP–388	1	Pot - Trimpot - Panel Mount	Bourns 3012P-1-502
R1251	MR–253	2	Resistor - 4.02K - 1% - ½W - MF	Texas Instrument
R1252	MR–238	4	Resistor - 15K - 1% - ½W - MF	Texas Instrument
R1253			Same As R1252	
R1254	MR–1041	2	Resistor - 6.19K - 1% - ½W - MF	Texas Instrument
R1255			Same As R1251	
R1256	MR–356	2	Resistor - 680 ohm - 10% - ¼W - Comp.	Allen Bradley
R1257	MR–483	2	Resistor - 1.5K - 10% - ¼W - Comp.	Allen Bradley
R1258			Same As R1256	
R1259	MR–1040	2	Resistor - 525 ohm - 1% - ½W - MF	Texas Instrument
R1260			Same As R1252	
R1261			Same As R1252	
R1262	MR–559	1	Resistor - 50K - 1% - ¼W - WW	Gamble
R1263			Same As R1257	
R1264			Same As R1254	
R1265			Same As R1259	
R1266			Not Assigned	
R1267	MR–244	1	Resistor - 33.2K - 1% - ½W - MF	Texas Instrument
R1268	MR–143	1	Resistor - 33K - 10% - ¼W - Comp.	Allen Bradley
R1269	MR–814	1	Resistor - 3.9K - 10% - ¼W - Comp.	Allen Bradley
R1270	MP–380	1	Pot - 10K	Beckman 77PR10K
R1271	MR–1073	1	Resistor - 107K - 1% - ½W - MF ±25PPM	Texas Instrument
R1272	MR–986	1	Resistor - 3.48K - 1% - ½W - MF	Texas Instrument
R1273	MR–1006	1	Resistor - 1K - .025% - ¼W - WW	Gamble
R1274	MR–1005	1	Resistor - 270K - 0.1% - ¼W - WW	Gamble
R1275	MR–1072	1	Resistor - 909K - 1% - ¼W - MF ±25PPM	Texas Instrument
R1276	MP–389	1	Pot - 10K	Bourns 37075-10K
R1277	MP–390	1	Pot - 100 ohm	Bourns 37075-100 ohm
SW1250	MS–367	1	Switch - DPDT	ALCO MST-205P
SW1251	MS–355	1	Switch - W/Pot Assembly	CTS 2212
SW1252	MS–351	2	Switch - SPDT	ALCO MST-105D
SW1253	MS363	1	Switch	Helipot 1390-35-0
SW1254			Same As SW1252	
TB1250	MB–109	1	Barrier Strip	Cinch Jones 7-172

houston instrument | DIVISION OF BAUSCH & LOMB

Module Serial No. _____

TYPE 50-1 52
DRIVE MODULE



SPEED SELECTION: A ten position interlocked switch. In the off position no drive signal is fed to the recorder. Any other selection acts as a divider to the basic clock signal and sends proportionate drive signals to the recorder to give the indicated chart speeds.

CIRCUIT DESCRIPTION: Fundamentally, this module is a switchable pulse divider. The clock signal is fed through the module and returned by a normally used jumper. Choice of any pushbutton simply divides the clock signal and sends it to the recorder stepper drivers. It is also available at the rear of the module to act as driving signal for any stepper motor that could be slaved.

This module may be used several ways:

1. Conventionally — where a sweep speed is chosen directly by pushing the appropriate pushbutton.

2. Remote drive — an external source of pulses (linear, characterized, non-linear, etc. from logic, or other sources) is fed into the buffer after disconnecting the clock reference. Subject pulses can go directly into the recorder by using the 20 in/min pushbutton or can be divided using other pushbuttons. See table. Pulses should be greater than 5 volt positive going into a 10K ohm load. Rate should not exceed 200 pulses per second.

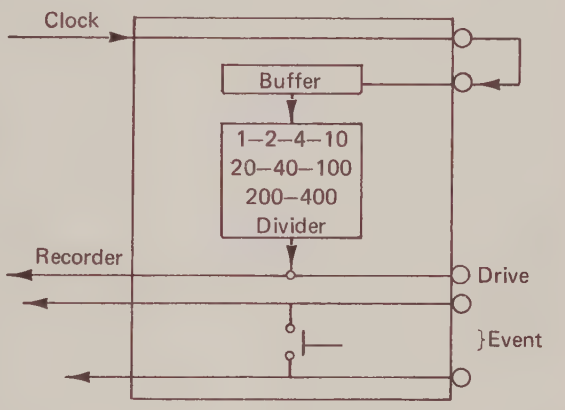
3. Combination — the clock signal may be fed to an external manipulator and returned as the driving source to the module on a 1 to 1 basis (20 in/min pushbutton) or further divided by pushbutton choice.

DIVISION RATIO
PER PUSHBUTTON CHOICE

in/min	20	10	5	2	1	0.5	0.2	0.1	0.05
Divisor	1	2	4	10	20	40	100	200	400

Each delivered pulse drives the chart 1/360 inch for 60 hz. units (1/300 for 50 hz.)

EVENT MARKER: Manual pushbutton. When used on the 3000 Series of recorders, depressing will actuate the event marker pen to provide an arc mark. When used on the 4000 Series TY® Recorders, actuation initiates a sweep or curtails the sweep (with automatic reset). A parallel set of terminals is provided at the rear of the module for remote actuation.



Specific theory of operation finds, in the circuit diagram, the clock signal entering Pin 17 and going directly to the terminal strip. The normally used external jumper returns it to the module and thence to a buffer composed or Q-1350. Still at clock frequency (120 pps for 60 hz. and 100 pps for 50 hz. mains) it then passes directly to the pushbutton divider. IC's 1350, and 1351 are identical, each having a ÷ 2 and ÷ 5 ability. They are hooked in series by the pushbutton switch such that any part of the proper ratio may be chosen. Typically for 1 inch per minute the clock signal enters IC-1350 where it is divided by 2, exits, re-enters and is further divided by 5; then to IC-1351 to be divided by 2 and then to the proper pushbutton choice contact. It appears on the pushbutton rail and also at Pin 16 which is the drive source for the recorder. Concurrently it appears at the terminal strip where it can be used to drive an external stepping motor. IC-1352 is a dual flip flop providing either ÷ 2 or ÷ 4 as the end dividers of the series chain. SW-1350 is used for event actuation.

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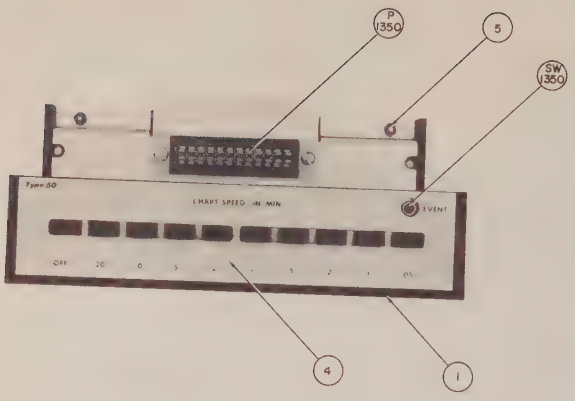
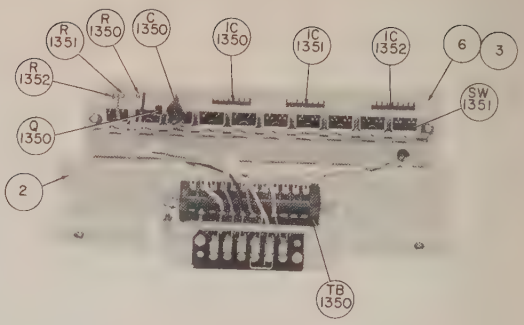
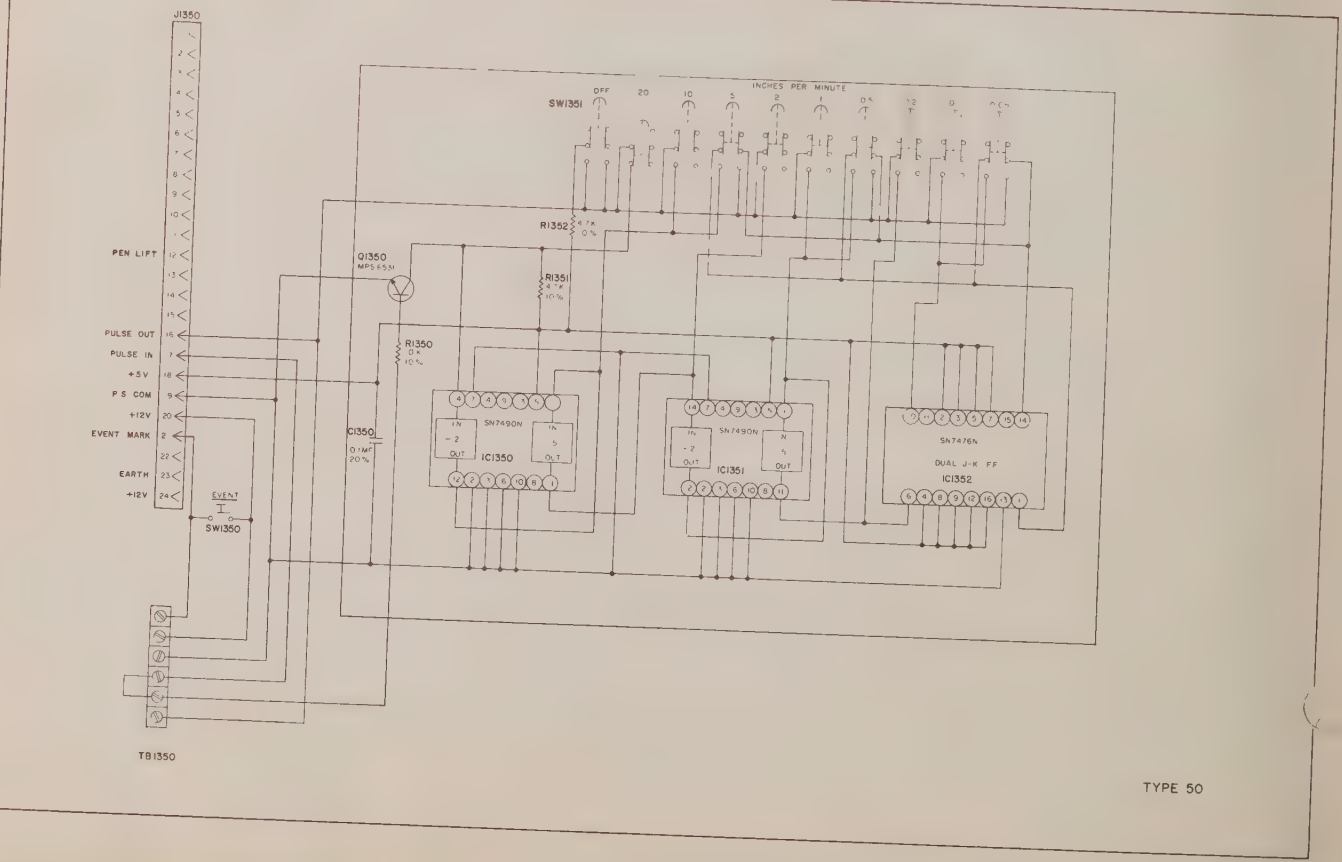


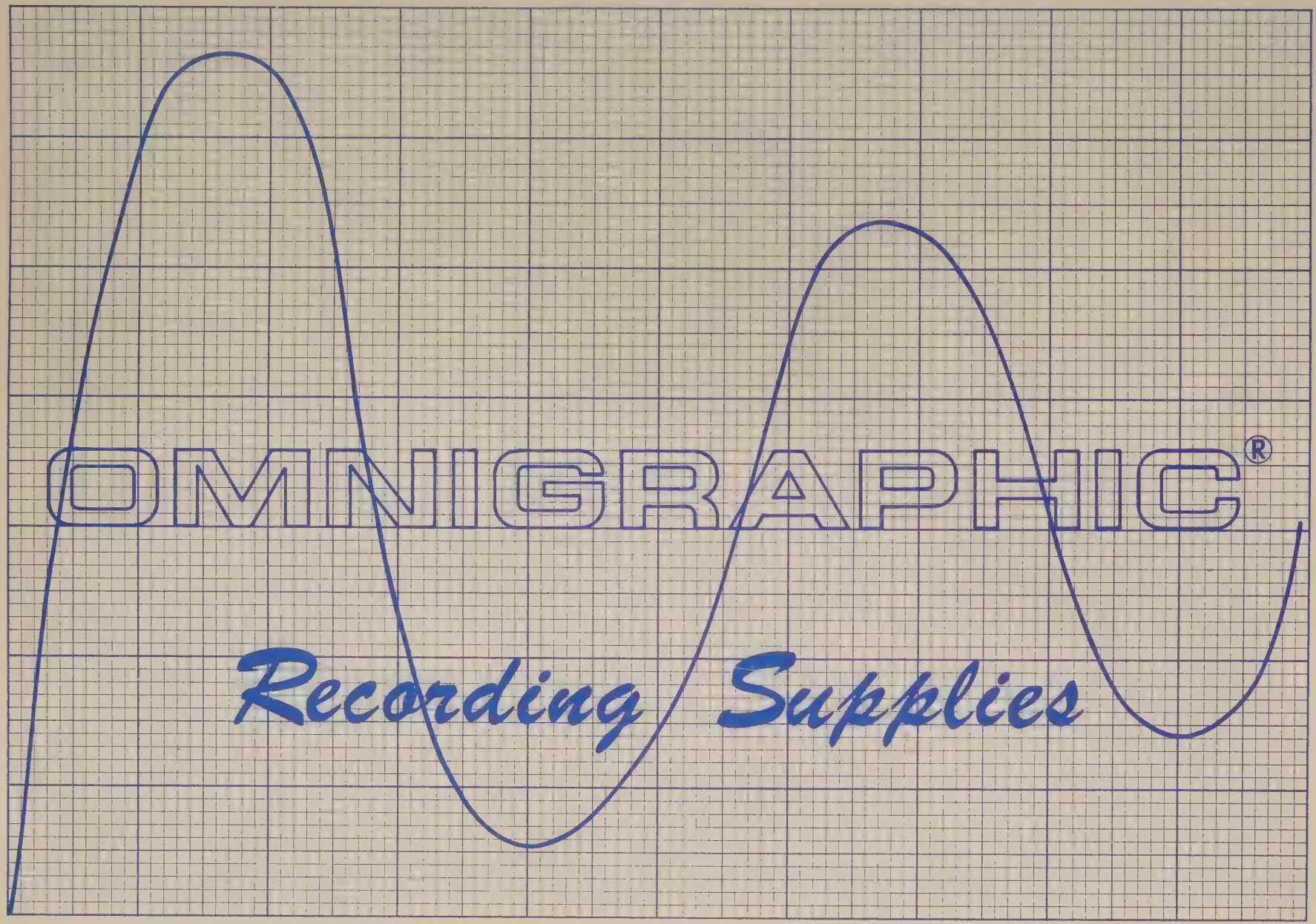


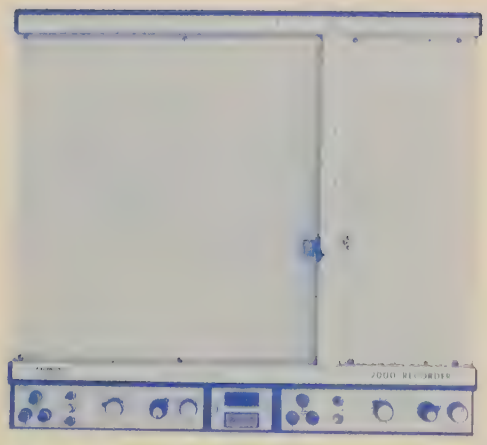
PARTS LIST TYPE 50

REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
1	2000–128	1	Case Moulding - Machined	Houston Instrument
2	2000–129	1	Chassis	Houston Instrument
3	2000–269	1	P. C. Board - Drilled	Houston Instrument
4	2000–246	1	Decal - Front Panel	Houston Instrument
5	2000–4	2	Alignment Post	Houston Instrument
6	2000–268	1	P. C. Board - Assembly	Houston Instrument
SW1350	MS–372	1	Switch - Pushbutton	Cutler Hammer 5AIRV20
P1350	MC–835	1	Connector	Amphenol 36-4100-24P
TB1350	MB–93	1	Barrier Strip	Cinch Jones 6-172
R1350	MR–114	1	Resistor - 10K - 10% - ¼W - Comp.	Allen Bradley
R1351	MR–125	2	Resistor - 4.7K - 10% - ¼W - Comp.	Allen Bradley
R1352			Same As R1351	
Q1350	MQ–28	1	Transistor - MPS6531	Motorola
C1350	MC–480	1	Capacitor - 0.1 MF - 5% - 200V -	Packtron MB-800
IC1350	MW–144	2	Integrated Circuit - SN7490N	Texas Instrument
IC1351			Same As IC1350	
IC1352	MW–118	1	Integrated Circuit - SN7476N	Texas Instrument
SW1351	MS–349	1	Switch - P. C. Terminals	Switchcraft 65101K-206



TYPE 50


OMNIGRAPHIC®
Recording Supplies



OMNIGRAPHIC® RECORDING SUPPLIES

OMNIGRAPHIC® recording charts are printed on special paper stock, selected for minimum distortion resulting from changes in temperature and humidity. OMNIGRAPHIC® charts are photo–optically cut to insure perfect alignment of paper edges and chart grid lines. Porosity is controlled within narrow limits for proper inking under nearly all conditions. Custom grids can be supplied on special order.

Inks supplied with OMNIGRAPHIC® capillary and fibre tip pens are specially formulated to combine several important qualities. Viscosity and flow characteristics match OMNIGRAPHIC® chart paper stocks over a wide range of writing speeds, temperature and relative humidity. The resulting traces are sharply defined, of uniform width, and can be reproduced by most xerographic and diazo processes.

INDIVIDUAL CHART SHEETS

Individual chart sheets are supplied in 8½ X 11 inches and 11 X 16½ inches sizes. Heavy (H) weight general purpose recording sheets are similar in weight to notebook paper. Light (L) weight paper is semi–transparent, suitable for diazo reproduction. Chart grids are in green. Packed 100 sheets to a box; shipping weight is approximately two pounds per box.

CATALOG NUMBER	PAPER WEIGHT	PRICE PER BOX	PAPER SIZE	GRAPH SIZE	MAJOR DIVISIONS	MINOR DIVISIONS
34504	H or L	$5.00	8½ X 11 in.	7 X 10 in.	7 X 10	70 X 100
81012	H or L	5.00	8½ X 11 in.	6.7 X 10 in.	10 X 12	100 X 120
101512	H or L	6.00	11 X 16½ in.	10 X 15 in.	10 X 12	100 X 120
101515	H or L	6.00	11 X 16½ in.	10 X 15 in.	10 X 15	100 X 150
101538	H or L	6.00	11 X 16½ in.	25 cm X 38 cm	25 X 38	250 X 380

CHART ROLLS

Charts for VOM and OMNIGRAPHIC® strip chart recorders are supplied in 100 foot rolls having 5 in., 10 in., and 25cm. calibrated grid width. In general only the charts listed can be used on designated recorders, and the charts listed can't be used on recorders other than those designated. Chart grids are in green. Chart rolls are packed one roll per box; shipping weight is approximately two pounds per roll.

CATALOG NUMBER	PRICE PER ROLL	LENGTH PER ROLL	GRID WIDTH	MAJOR DIVISIONS X AXIS	MAJOR DIVISIONS Y AXIS	MINOR DIVISIONS X AXIS	MINOR DIVISIONS Y AXIS	USE ON RECORDER MODEL NO.
37–01–31	$2.75	100 ft.	5 in.	1 in.	.5 in.	.25 in.	.05 in.	5, 6, 7, 8
37–01–32	3.45	100 ft.	5 in.	1 in.	.5 in.	.25 in.	.05 in.	5, 6, 7, 8
37–01–33	3.45	100 ft.	5 in.	1 in.	.5 in.	.25 in.	.05 in.	5, 6, 7, 8
37–01–37	4.10	100 ft.	5 in.	1 cm.	1 cm.	5 mm	1 mm	5, 6, 7, 8
37–01–81	4.00	100 ft.	5 in.	1 in.	1 in.	.25 in.	.05 in.	6
37–03–09	3.90	100 ft.	10 in.	1 in.	1 in.	.25 in.	.05 in.	10, 11
RC–109	3.90	100 ft.	10 in.	1 in.	1 in.	0.1 in.	0.1 in.	3000, 2–3000
RC–110	3.90	100 ft.	25 cm.	1 in.	1 cm.	0.1 in.	0.1 in.	3000, 2–3000
RC–115	3.50	100 ft.	10 in.	Blank	Blank	Blank	Blank	3000, 2–3000
RC–129	3.90	30.5 Meters	25 cm.	2 cm.	5 cm.	4 mm	2 mm	3000, 2–3000

Z–FOLD CHART PACKS

OMNIGRAPHIC® 6000 Series instruments comprise a group of recorders and plotters of unusual versatility. Features such as automatic chart positioning are made possible by the use of Z–fold, or fan fold, chart packs instead of individual sheets or rolls. The standard pack consists of a continuous 12 in. strip up to about 144 feet in length, perforated and folded every 8½ inches. Chart grids are available in various formats, in general either a continuous grid of more or less unlimited length, or individual 7 X 10 in. or 10 X 15 in. charts. Packs of Z–folded blank charts are supplied for applications in which a pre–printed grid is not wanted.

OMNIGRAPHIC® Z–fold chart packs are manufactured under rigidly controlled conditions for uniformity and accuracy. Finished charts are packed and sealed in plastic bags at 72°F, 50% relative humidity, and individually boxed. It is recommended that chart paper be stored in the same environment as nearly as possible.

Before loading a new chart pack, the pack should be fanned or riffled at both sides to separate the sheets. After the pack is used up the perforated sprocket hole strips may be removed and the pack filed flat. The Z–fold arrangement permits easy access to any portion of the record. Individual charts may be removed from the pack. Packs may be spliced together to form indefinitely long charts.

Z–FOLD RECORDER PAPER

SPECIFY	PRICE	X AXIS	Y AXIS	X & Y MAJOR X AXIS	X & Y MAJOR Y AXIS	MINOR DIVISION X AXIS	MINOR DIVISION Y AXIS	6420	6450 6452	6520	6540	6550	6650 6655
FC–0	$4.50	Cont.	7 in.	Blank	Blank	–	–	o		o			
FC–10	5.50	10 in.	7 in.	.5 in.	.5 in.	.10 in.	.10 in.	✓		o			
FC–10M	5.50	25 cm.	18 cm.	1 cm.	1 cm.	1 mm.	1 mm.	✓		o			
FC–20	5.50	Cont.	7 in.	.5 in.	.5 in.	.10 in.	.10 in.	o		o			
FC–20M	5.50	Cont.	18 cm.	1 cm.	1 cm.	1 mm.	1 mm.	o		o			
FC–000	5.50	Cont.	11 in.	Blank	Blank	–	–		o		o	o	o
FC–30	7.00	15 in.	10 in.	1 in.	1 in.	.10 in.	.10 in.		o		o	o	o
FC–40	7.00	Cont.	10 in.	1 in.	1 in.	.10 in.	.10 in.		o		o	✓	✓
FC–43	7.00	Cont.	10 in.	1 in.	3 log.	.10 in.	–		o		o	o	o
FC–44	7.00	Cont.	10 in.	1 in.	4 log.	.10 in.	–		o		o	o	o
FC–45	7.00	Cont.	10 in.	1 in.	5 log.	.10 in.	–		o		o	o	o
FC–46	7.00	Cont.	10 in.	.75 in.	5 log.	.10 in.	–		o		o	o	o
FC–47	7.00	Cont.	10 in.	1 in.	6 log.	.10 in.	–		o		o	o	o
FC–50	7.00	15 in.	10 in.	.5 in.	.5 in.	.05 in.	.05 in.		✓		✓	o	o
FC–50M	7.00	38 cm.	25 cm.	1 cm.	1 cm.	1 mm.	1 mm.		✓		o	o	o
FC–60	7.00	Cont.	10 in.	.5 in.	.5 in.	.05 in.	.05 in.		o		o	o	o
FC–60M	7.00	Cont.	10 in.	1 cm.	1 cm.	1 mm.	1 mm.		o		o	o	o
FC–70	7.00	10 in.	7 in.	.5 in.	.5 in.	.05 in.	.05 in.		o		✓	o	o
FC–70M	7.00	18 cm.	25 cm.	1 cm.	1 cm.	1 mm.	1 mm.		o		o	o	o
FC–103	7.00	15 in.	10 in.	3 log.	3 log.	–	–		o		o	o	o

Availability stock to 30 days.
✓ Indicates chart furnished initially with recorder.
o Indicates may also be used.
Each pack contains 102 individual chart grids or 11 X 16½ inch sheets.

P–40 TYPE

DISPOSABLE FIBRE TIP PENS – FOR ALL OMNIGRAPHIC® RECORDERS

No mess, no cleaning or filling. Write 1500 feet of crisp trace of uniform width. Use with OMNIGRAPHIC® 2000/3000 and all models VOM recorders. Can be used with OMNIGRAPHIC® 6450, 6452 and 6540 with optional pen holders.

P–40 Red, P–41 Blue, P–42 Green, P–43 Black, P–52 Red and Black.

Pack of 10 fibre tip pens ..... $12.00.

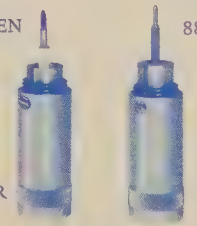
PENS AND INK FOR 6000 SERIES Z–FOLD RECORDERS

Capillary pens using disposable ink cartridges are normally supplied with OMNIGRAPHIC® 6450, 6452, and 6540 recorders. These pens make a dense and uniformly wide trace at normal and high writing rates. Pen holders are available permitting the use of P–40 type fibre tip pens.

Two types of pen holders and pens are supplied with OMNIGRAPHIC® 6650 and 6655 Incremental Plotters. A constant fine trace of about .006 inch width is made by the ball point pen. The fibre tip pen draws a bold trace.

8700 PEN

8800 PEN



8920 PEN HOLDER

8910 PEN HOLDER

8400 PEN HOLDER

8500 PEN HOLDER

8300 INK CARTRIDGE

PENS AND INK CARTRIDGES

FOR RECORDER	CATALOG NO.	PRICE
6420, 6450, 6452 (Lower Pen), 6520, 6540	8400	$17.50
6452 (Upper Pen)	8500	25.00
INK CARTRIDGES FOR ABOVE Specify Red, Blue, Black, Green, or mixed; Box of 16	8300	10.00

FIBER TIP HOLDERS AND PENS

6450, 6452 (Lower Pen)	6452–73	17.50
6452 (Upper Pen)	6452–74	25.00
6650, 6655	8920	45.00
For all OMNIGRAPHIC® Recorders Except 6650, 6655, Ten Pens Per Pack	P–40 Red	12.00
	P–41 Blue	12.00
	P–42 Green	12.00
	P–43 Black	12.00
	P–52 Red & Black	12.00
6650, 6655 Pack of 20 Fibre Tip Pens Specify Red, Blue, Black, Green, Mixed – 5 of each color	8800	20.00

BALL POINT PEN HOLDER AND PENS

6650, 6655 – Pack of 20 Ball Point Pens. Specify Red, Blue etc.	8700	20.00

QUANTITY DISCOUNTS

1–4	5–9	10–24	25–49	50 UP
NET	5%	10%	12.5%	17.5%

NOTE: Catalog Numbers May Not be Mixed For Additional Discounts. Ink & Pen Colors May be Mixed For Maximum Discount.

REPRESENTED BY

THE RECORDER COMPANY | houston instrument

4950 TERMINAL AVENUE. BELLAIRE. TEXAS 77401

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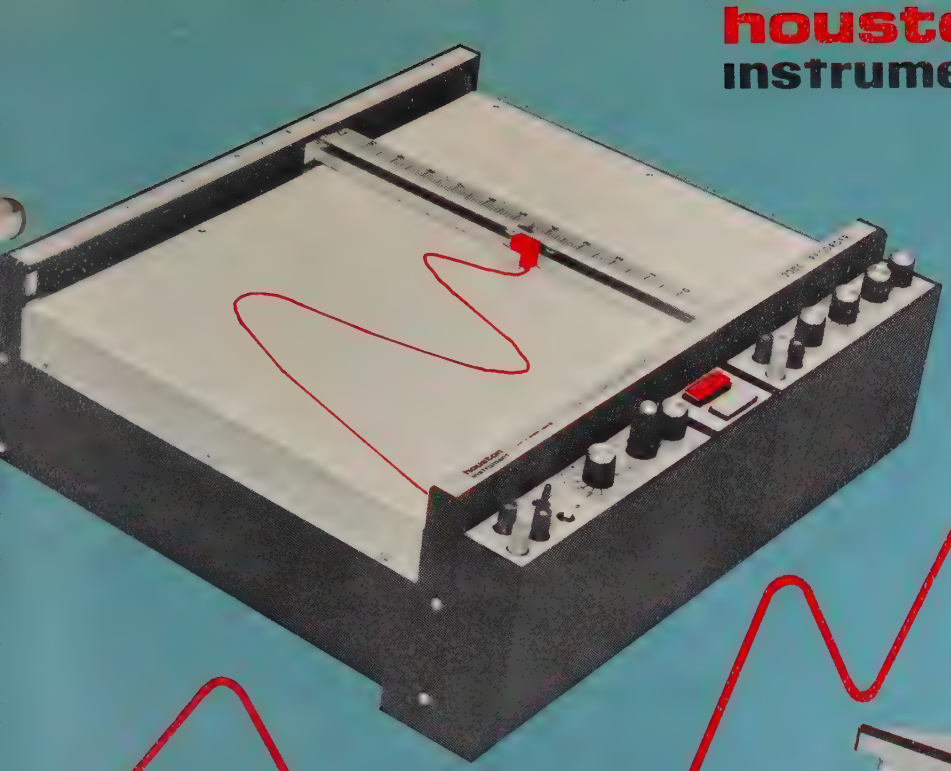
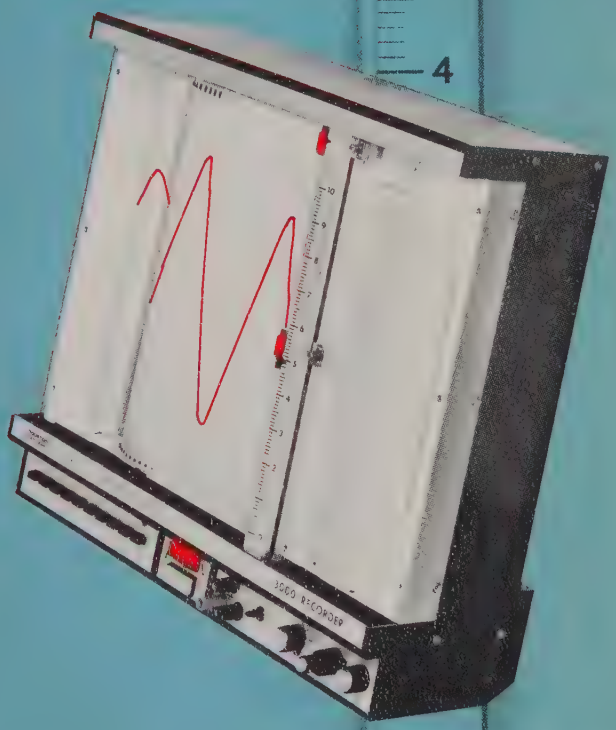
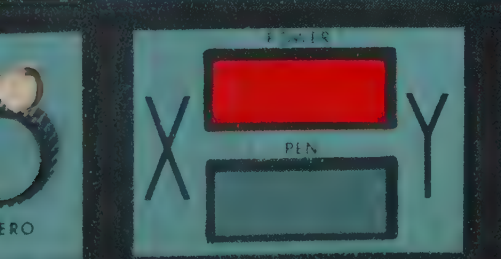




SERIES 2000 & 3000 RECORDERS

OMNIGRAPHIC®

2000 RECORDER



OUTSTANDING FEATURES

2000 X–Y
3000 STRIP CHART

DIFFERENTIAL INPUT: Measures from any type of source up to ±500 volts from ground. Isolation and common mode rejection are so good that shields and guards are not needed.

MOUNTING: Bench, Rack or Panel in vertical or horizontal planes.

ZERO CHECK POSITION: A standard feature on most modules. Without disconnecting the signal, zero position can be verified and scaled.

ALL SOLID STATE: State of the art IC's. No mechanical or light diode choppers. No tubes or nuvistors. No warm-up for calibrated operation.

CONSTRUCTION: Case and modules are unbreakable, mar resistant ABS black plastic, with a textured surface. This instrument will look new for years. It is not susceptible to nicks and scratches. Interior frame is injection cast aluminum. All other parts are plastic, stainless steel or anodized aluminum.

WEAR COMPENSATING MECHANISM: State of the art design eliminates adjustment. Cleanliness is desired, but not essential. No lubrication ever.

INCH/CENTIMETER SCALING: Front panel switch, on modules, allows calibration of recorder in inches or centimeters, as related to the paper grid.

ACCESS: Sides, bottom and top are removable in seconds for complete access to any portion – either individually or completely.

PEN LIFT: Electric with positive action. Failsafe on power failures. Local and remote control via isolated contact closure.

PENS: A constant line trace regardless of speed or use. Snap on, disposable unit includes pen tip and ink. No need ever for complicated cleaning procedures or overnight plugging. Pens will write after weeks unused. Capillary ink pen option.

OVERSHOOT: Not discernible on normal step inputs. Less than 1% on full scale step inputs.

HIGH PERMISSIBLE SOURCE RESISTANCE: As sources approach and exceed the 10^5 ohms domain, neither dead zone nor repeatability is affected; common mode and frequency response only mildly; calibration normally.

VERSATILITY: Laboratory or field, production or process, OEM or dedicated – all are ideal for this recorder. The completely self contained frame stands alone, but can act as the basic building block for the modules. There is no duplication in circuitry. The design is so basic that no part contains a premium capability.

SEALED REBALANCE POTENTIOMETERS: No cleaning ever, with extended life. Recorder uses its own limit stops and a friction clutch to give added protection to the pot and the entire mechanics.

INPUT MODULES: Plug-in modules give choice of function and cost. Each gives front panel and remote control. All units plug-in and are interchangeable in moments. Most modules even work in the related X–Y, Strip Chart, and TY® Recorders.

MODULE CONTROLS: Logically placed for unthinking use. Each control is always in the same place, regardless of module type.

DYNAMIC PERFORMANCE: Less than 1/3 second full scale with extremely high acceleration. Add critical damping and the recorder has unbeaten recording fidelity.

ACCURACY: Conservatively rated at ±0.2% overall inaccuracy, the typical recorder has linearity, calibrated errors and dead zones less than the trace width.

NOISE REJECTION: Unexcelled for common and normal mode rejection. Acute care in the layout and individual testing, combines with the differential nature to increase rejection by orders over conventional units.

ENVIRONMENTAL: Completely unaffected by wide variations in temperature, humidity, line voltage, or frequency.

MODULAR CONSTRUCTION: Amplifier, drive assemblies, and of course modules, are individually removable. They may be swapped with the complementary lines of X–Y, Strip Chart, and TY® Recorders.

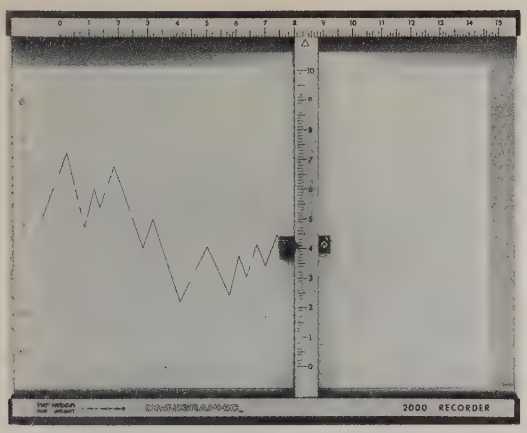
PAPER SIZE: Recorder will handle both 8-1/2 x 11 and 11 x 17 inch paper sizes, along with European types A4 and A3. With the inch/centimeter flexibility, the recorder is universal the world over – independent of discipline or national origin.

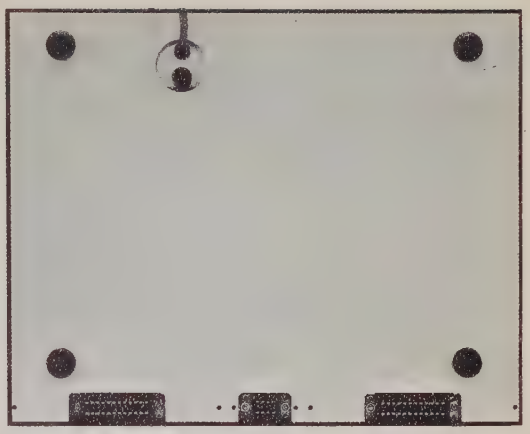
VACUUM HOLDDOWN: Silent retention of the paper. Unaffected by dust, temperature, humidity, line frequency or voltage. Contaminants pass thru the impeller turbine system which grips from mass air flow rather than ΔP. Maintenance free with no shock hazard.

INTERCHANGEABLE AMPLIFIERS: Each axis has a completely independent servo mounted on its own plug-in circuit board. They may be swapped or even used in the complementary line of strip and T–Y® Recorders.

X–Y CONFORMITY: Acceleration, slewing speed, phasing and damping of X and Y axis drives in 2000 series recorders are matched for minimum error under dynamic conditions. Essential in analyzer, calculator, computer readout applications.

THE MAINFRAME





From any angle:

- Mechanical
- Electrical
- Price
- Flexibility

→ UNBEATABLE

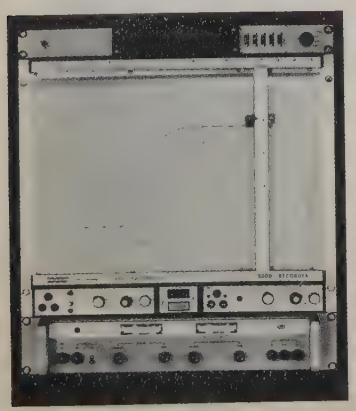
The mainframe is a complete working recorder without front panel controls. All inputs are via individual rear input connectors. Power and pen control, using contact closures, are via a separate rear connector. Input resistance is potentiometric with no less than 2 megohm slewing resistance. Zero is fixed or can be remotely controlled by running three shielded wires to an external 5K pot.

Power may be either 115 or 230 volt A. C. and is field convertible from one to the other. Case is mar resistant and unbreakable plastic, with a textured black finish. Bottom, sides and top are separately removable, involving only a total of eight screws. Total exposure is a minute's work. Sub–assemblies are all modular and field replaceable as units. Amplifiers are separate and interchangeable.

Standard accessories include five pens each of red and blue, instruction manual, plastic dust cover, spare fuse and cable, and Bristol wrenches. All are shipped in a specially molded styrofoam case.

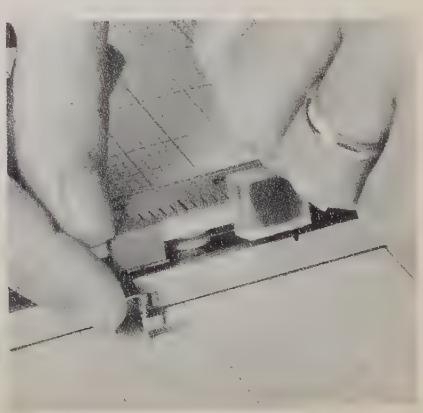
As a stand–alone unit, the mainframe is ideal for dedicated applications, where operational controls are better suited with the primary measurement or instrument controls, and most certainly as an OEM recorder. It offers the advantages of later expansion by addition of modules – without modification, and at any time.

And most certainly, the mainframe acts as the basic building block for general purpose recording by adding input and control modules. The same remote connectors mate directly into the plug–in modules, giving front panel control with wide variety.

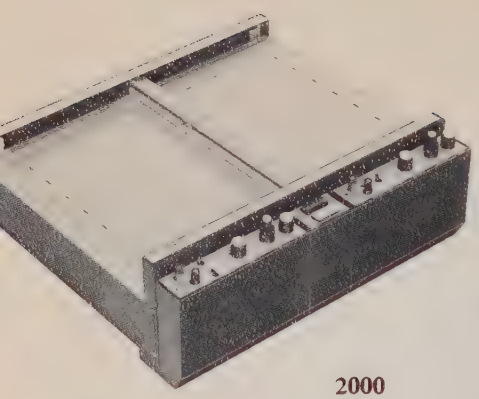


Rack

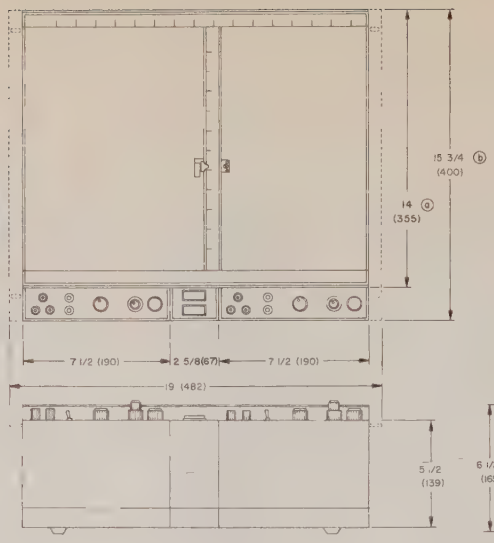
Bench

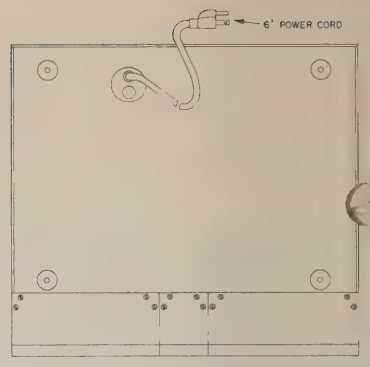


Pens Are Disposable and Snap on

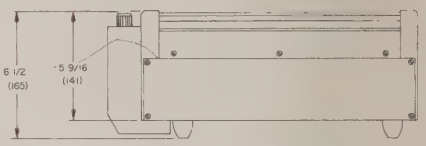


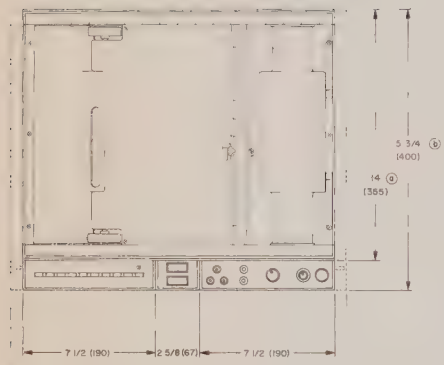
2000

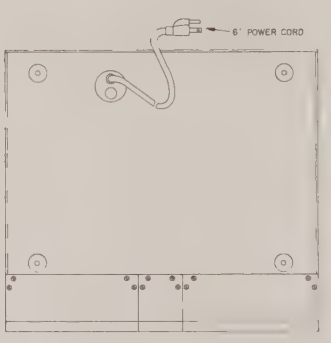




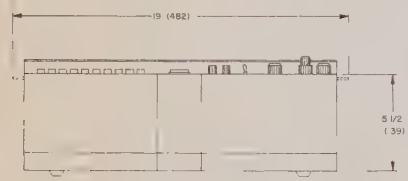
ALL DIMENSIONS IN INCHES AND (MILLIMETERS)

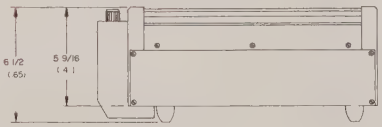




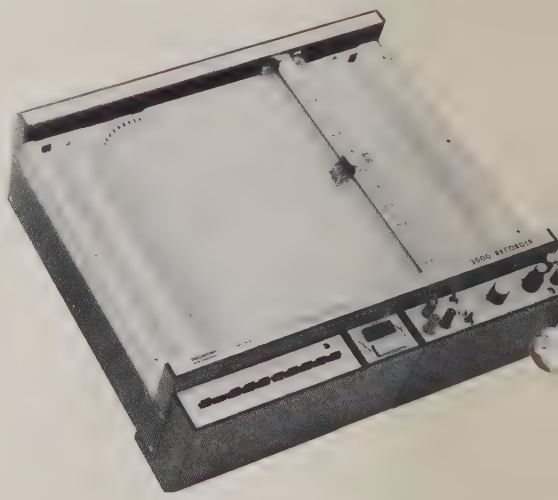


ALL DIMENSIONS IN INCHES AND (MILLIMETERS)

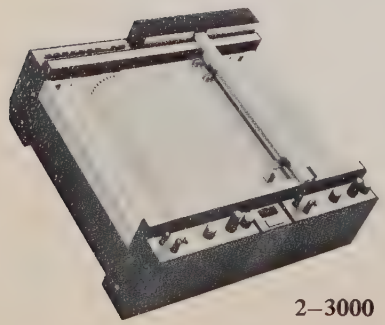




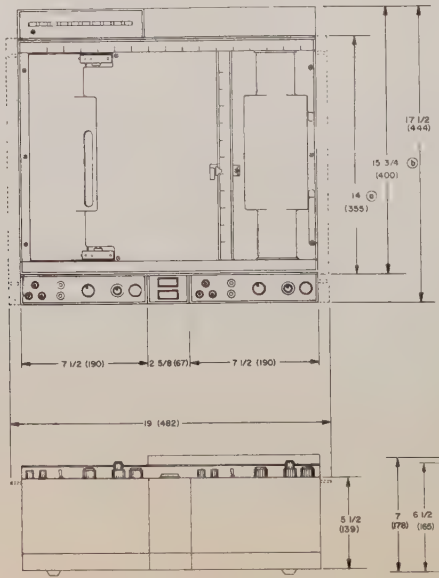
NOTE:
a WITHOUT MODULE
b WITH MODULE

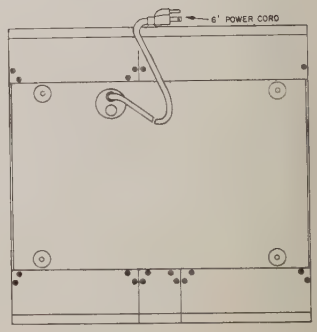


3000



2–3000





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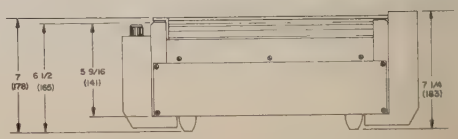


MAINFRAME SPECIFICATIONS

X and Y AXES – 2000 X–Y RECORDER
Y AXIS – 3000 STRIP CHART RECORDER
Y1 and Y2 AXES – 2–3000 STRIP CHART RECORDER

RECORDING MECHANISM: Potentiometric servo with sealed rebalance potentiometer. Long life, snap-in, disposable pen.

RESPONSE TIME: 1/3 second full scale maximum independent of line voltage or frequency. Optional – 1/4 second.

ACCELERATION: > 1500 in/sec^2 (3750 cm/sec^2) on 1/3 second instrument; > 1800 in/sec^2 (4500 cm/sec^2) on 1/4 second instrument.

OVERSHOOT: Critical damping. Less than 1% overshoot on full scale steps; overshoot is not discernible on half scale or less steps.

ACCURACY: ±0.2% of full scale.

LINEARITY: ±0.1% of full scale.

REPEATABILITY: ±0.1% of full scale.

RESETABILITY: ±0.05% of full scale.

INPUT CHARACTERISTICS: Differential and floating to ±500 VDC or peak AC above ground.

INPUT RESISTANCE: Potentiometric; modulator input is shunted by 0.1 microfarad capacitor.

SENSITIVITY: Basic sensitivity of 1 mv/inch (0.5 mv/cm) is set by external gain control resistors.

STANDARDIZATION: Continuous double regulated zener with temperature compensation (±0.0025%/°C).

COMMON MODE REJECTION: On most sensitive range; 140 db at DC; 140 db at line frequency with up to 1K source resistance. Decreases 20 db per decade of attenuation for both AC and DC.

CHART AXIS
3000 and 2–3000 STRIP CHART RECORDER

CHARTS: 100 foot chart rolls, 12 inches wide with 10 inches or 250 mm writing width.

CHART FEED: Roll take up or positive paper feed, depending on operator choice.

CHART DRIVE MECHANISM: Stepper motor, unidirectional drive.

CHART SPEED: Proportional to chart drive pulse rate to 40 inches/minute at 360 pulses/inch chart motion, (300 pulses/inch in 50 Hz recorder).

DRIVE PULSE REQUIREMENTS: +5 to +50 volts into 10K ohms, D.C. coupled. Maximum pulse rate is 200 per second. Pulse rise, on, and off times are not critical, but the pulses should be at least 10 microseconds wide.

EVENT MARKER: Single event marker is actuated by closure of a pair of contacts. Contacts make and break 12 volt, 0.5 amp inductive circuit.

GENERAL SPECIFICATIONS

PEN UP/DOWN: Closure of a pair of contacts lowers recording pen; opening the contacts raises pen. Contacts make and break 12 volt, 0.5 amp inductive circuit.

MOUNTING: Bench, rack, or panel. May be mounted at any angle to 90° any axis.

WEIGHT: With modules, 30 lbs. (13.5 Kg); shipping 34 lbs. (15.3 Kg). Mainframe only 26 lbs. (11.7 Kg).

ENVIRONMENTAL: 0 to 40°C operating. –10 to 60°C storage; 0–95% relative humidity at 30°C dry bulb.

POWER: 2000 X–Y Recorder – 115/230 VAC; 50–60 Hz; 60 volt amperes.
3000 and 2–3000 Strip Chart Recorders – 115/230 VAC; 50 or 60 Hz; 50 volt amperes. If Type 50 or 52 Time Base module is to be used and line frequency is 50 Hz, the recorder must be ordered for 50 Hz. operation.

TERMINAL BOXES: For O.E.M. and dedicated use. Where the various functional modules are not used the recorder is shipped with terminal boxes. These are installed in the module connectors on the underside of the recorder. Signal and control input circuits in the recorder are accessed via barrier strips installed in the terminal boxes. Consult Houston Instrument or its representative for additional details concerning O.E.M. applications.

PRICES
(Include terminal boxes, if installed)

Model 2000 X–Y Recorder	$ 770.00
Model 3000 Strip Chart Recorder	710.00
Model 2–3000 Two Pen Strip Chart Recorder	1080.00
Rack Mounting Wings	8.00

OPTIONS:

40 inch/second Servo	
2000 (Both axes only)	200.00
3000	100.00
2–3000 (Both axes only)	200.00
Retransmit Potentiometer	
2000 Per axis	50.00
3000 Y axis only	50.00
2–3000 Y1 axis only	50.00
High–Low Limit Switches –Per axis	75.00
115/230 VAC, 50 Hz. mains operation	No Charge

MODULES

Plug-in modules vastly expand the uses of the recorder mainframe. Modules provide front panel signal, power and pen controls for general purpose recording. In general, each is self contained and plugs directly into the recorder.

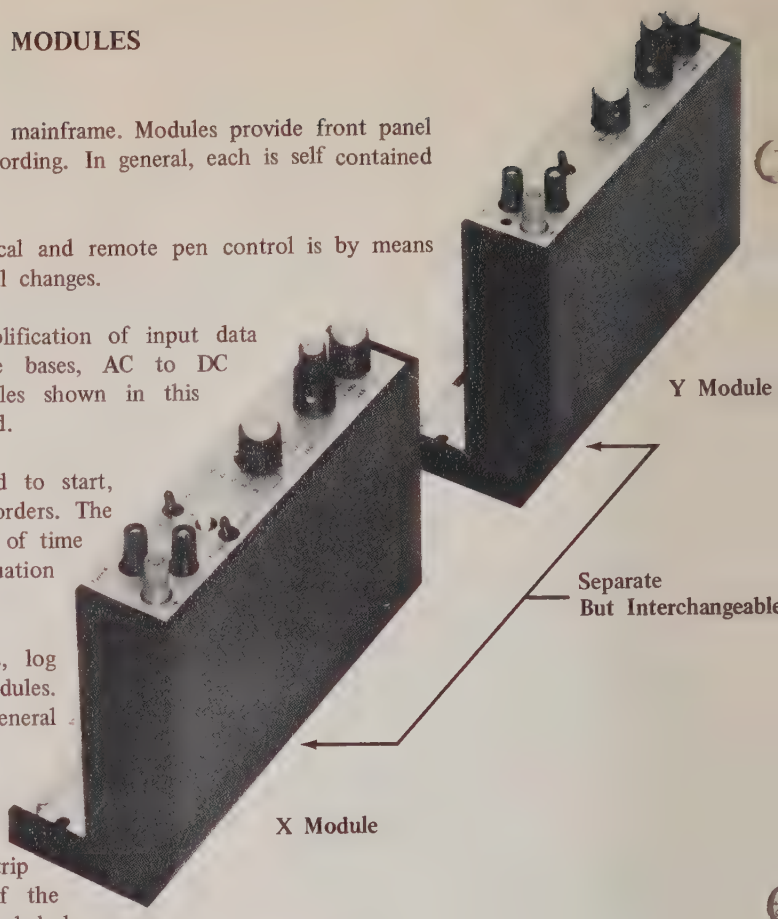
Control modules control line power, pen up/down. Local and remote pen control is by means of switch contact operation or, optionally, by logic level changes.

Signal module functions include attenuation and amplification of input data signals, generation of linear voltage ramps for time bases, AC to DC conversion. In addition to the standard signal modules shown in this brochure dozens of special modules have been developed.

Time base and chart drive control modules are used to start, stop, and control the chart speed of strip chart recorders. The event marker pushbutton is located on the front panel of time base modules. Remote start/stop and event marker actuation is accomplished by operation of switch contacts.

Point plotters, integrators, thermocouple compensators, log voltage amplifiers are examples of special function modules. In general these modules are interchangeable with general purpose plug-ins.

Most signal modules have universal five way binding post or BNC connectors on the front panel. All control, signal, and time base modules have barrier strip access to control and signal inputs at the rear of the modules. Signal and control cabling may be concealed by routing to the barrier strip along the underside of the recorder.

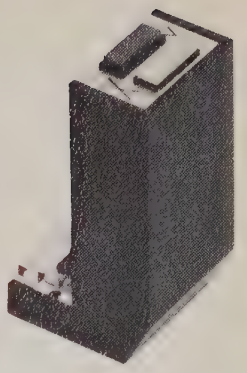


A BRIEF GUIDE TO MODULES

TYPE	DESCRIPTION	PURPOSE	USE WITH		
			2000	3000	2–3000
0	Customizing	"Do it yourself" – Signal Axis	*	*	*
00	Customizing	"Do it yourself" – Time Axis		*	*
1	DC Coupler	Dedicated; OEM	*	*	*
2	Ranging	Economy Variable Range	*	*	*
3	Switching	Economy Switched Attenuator	*	*	*
4	Switching/Time Base	Economy Switched Attenuator and Time Base	*		
5	Precision Attenuator	14 Calibrated Ranges	*	*	*
6	Precision Attenuator/Time Base	14 Calibrated Ranges and Sweeps	*		
7	Preamp/Attenuator	17 Ranges from 100 mv/inch	*	*	*
8	Preamp/Attenuator/Time Base	17 Ranges from 100 mv/inch and 18 Sweeps	*		
9	Precision Ranging	For Wide Range Precision	*	*	*
10	High Sensitivity AC	100 mv to 50 v/inch; AC only	*	*	*
11	Preamp; Fixed Span	100 mv/inch DC	*	*	*
12	Precision Attenuator/Offset	Up to 100:1 Offset	*	*	*
13	Integrator	Record Amplitude – Time Integral			*
14	Log Converter	1–2–3 Decade Log Amplifier	*	*	*
15	Two Channel Switching	Multiplex Two DC Signals	*	*	*
16/17	Point Plotter	Analyzer/Computer Readout		*	
18	Thermocouple Reference	Terminate JKS Thermocouples	*	*	*
20	AC/DC Switching	General Purpose AC and DC	*	*	*
26/17	Point Plotter	Analyzer/Computer Readout	*		

CONTROL MODULES

Lighted pushbuttons control AC power and pen up/down. Rear terminals allow remote control by switch contact operation. Required when signal or time base modules are used.



TYPE	DESCRIPTION	USE WITH			PRICE
		2000	3000	2–3000	
100	Power On/Off: Logic Level Remote Pen Control	*	*		$50.00
200	Power On/Off: Switch Contact Remote Pen Control	*	*		25.00
300	Same As Type 200; Legend for 2 Pen Recorder			*	25.00
400	Same As Type 100; Legend for 2 Pen Recorder			*	50.00

TIME BASE MODULES

Pushbutton selection of nine chart speeds and actuation of event marker. Chart speed is referenced to line frequency, to internal stable oscillator, or external pulse train.

CHART SPEEDS: In standard 3000 main frame:

Inches: .05, 0.1, 0.2, 0.5, 1, 2, 5, 10, 20 inches/minute.
Centimeters: 0.1, 0.2, 0.4, 1, 2, 4, 10, 20, 40 cm/minute.

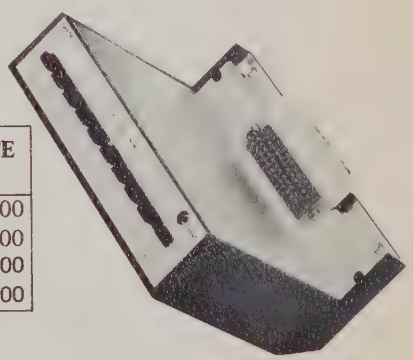
CHART SPEED ACCURACY:

Line frequency reference: Dependent on accuracy of line frequency.
Internal frequency reference: 0.1% of selected speed.

EXTERNAL PULSE INPUT:

0 to +5 volts or greater into 10K ohms. D.C. coupled, >10μ seconds duration, 200/second maximum.

SELECTION CHART

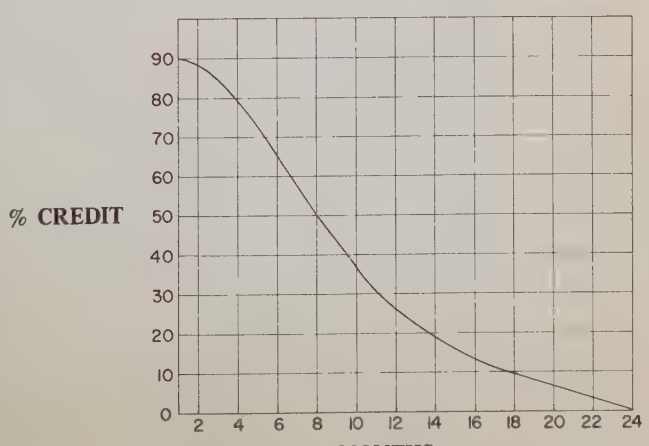


TYPE	CHART SPEED UNITS		REFERENCE FREQUENCY		USE WITH		PRICE
	IN/MIN	CM/MIN	LINE	INTERNAL	3000	2–3000	
50	*		*		*		$100.00
52	*		*			*	100.00
54	*	*		*	*		135.00
55	*	*		*		*	135.00

TRADE–IN POLICY: Inevitably, a new need is found for the recorder. And very possibly a different module best suits the new application. In study of the modules, one notes that each offers somewhat more than the predecessor. Effectively, a new module could obsolete the old unit. Houston abhors the shelves full of dust gathering modules created by some instruments. Only the most flexible units are desired - the others sit. Our wide selection of modules could create an identical situation.

A simple trade-in policy banishes this ill. Credit against a new module purchase is allowed on the old unit. Credit is proportionate to age — not use, other than normal wear and tear.

So purchase originally only that needed. Then later upgrade at a minimal premium. And never put one aside — trade it in.



MODULE TRADE–IN CREDIT

OMNIGRAPHIC® 3000 STRIP CHART RECORDERS

ADVANTAGES OVER CONVENTIONAL RECORDERS

LEFT TO RIGHT TRACE. Most units feed the paper top to bottom as a convenience to the manufacturer. Graphs are read by either head bending or artificially training the eye. The 3000 Strips read naturally, whether in a rack, on the bench, flat, or standing on end.

STATE OF THE ART CHART DRIVE. Speed changes are reflected in instantaneous chart movement. Other recorders using gear shifters or transmissions have objectionable time lapses while backlash is overcome.

PLUG–IN MODULES. Most conventional strips are application limited by fixed ranges. Some do have very wide ranges and commensurate prices. The 3000 can be either and can be changed at any time with the inexpensive modules.

CHART LOADING. Simple and direct, there are no magazines to remove – no threading around, in, and behind bars.

SNAP IN PENS, ELECTRIC PEN LIFT, AND EVENT MARKER are standard. Most strips use complicated capillary pen systems and only offer electric lifts and event markers as options.

FEATURES

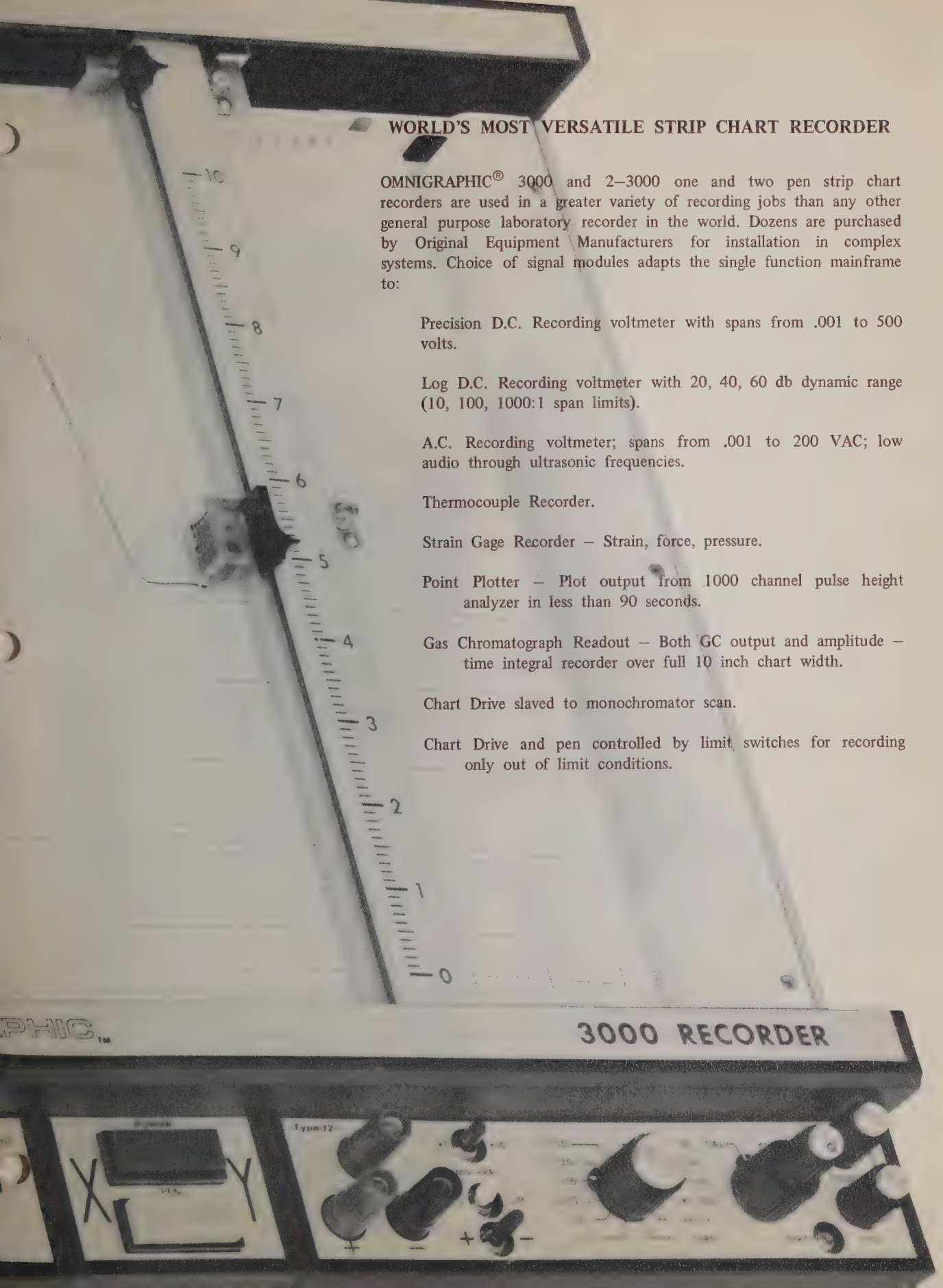
CHART: 10 inch (or 25 cm) wide chart grid, 100 foot roll.

NUMBER OF PENS: One and two pen recorders plus event marker are available. Second pen in two pen recorder is offset 0.3 inches so both pens can traverse full 10 inch chart width. Y axis (both in 2–3000) and event pens are raised and lowered together.

EVENT MARKER: A single event marker is a standard feature of both one and two pen recorders. The event marker is actuated by pushbutton on time base module or external contact closure.

DIGITAL CHART SPEED: Nine pushbutton selected speeds. Instantaneous reaction as there are no gear transmissions, clutches or kinematic wonders.

PAPER FEED: Roll takeup or positive paper feed without modification.



WORLD'S MOST VERSATILE STRIP CHART RECORDER

OMNIGRAPHIC® 3000 and 2–3000 one and two pen strip chart recorders are used in a greater variety of recording jobs than any other general purpose laboratory recorder in the world. Dozens are purchased by Original Equipment Manufacturers for installation in complex systems. Choice of signal modules adapts the single function mainframe to:

Precision D.C. Recording voltmeter with spans from .001 to 500 volts.

Log D.C. Recording voltmeter with 20, 40, 60 db dynamic range (10, 100, 1000:1 span limits).

A.C. Recording voltmeter; spans from .001 to 200 VAC; low audio through ultrasonic frequencies.

Thermocouple Recorder.

Strain Gage Recorder – Strain, force, pressure.

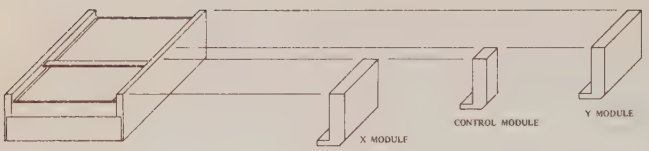
Point Plotter – Plot output from 1000 channel pulse height analyzer in less than 90 seconds.

Gas Chromatograph Readout – Both GC output and amplitude – time integral recorder over full 10 inch chart width.

Chart Drive slaved to monochromator scan.

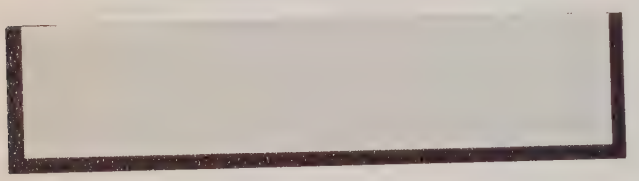
Chart Drive and pen controlled by limit switches for recording only out of limit conditions.

SIGNAL MODULES



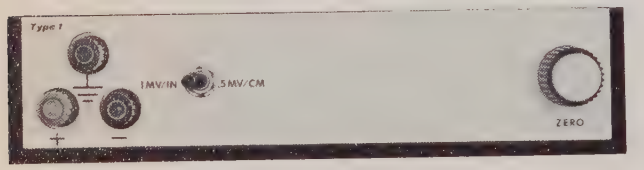
TYPE 0 – CUSTOMIZING: This module is ideal for specials. Comes complete with chassis, housing, blank front panel decal, mainframe connector and remote barrier strip. Precision resistors for amplifier scaling and IN – CM scaling are installed. For X and Y inputs to 2000 and Y input to 3000 (both Y channels in 2–3000).

PRICE: $25.00



TYPE 00 – CUSTOMIZING: Blank module for chart axis drive in 3000 and 2–3000 recorders. Includes chassis, housing, mainframe connector, and remote barrier strip.

Price: $25.00



TYPE 1 – DC COUPLER: A fixed sensitivity signal is fed via the input terminals directly into the recorder mainframe.

Front panel IN/CM scaling choice and zero control give operational flexibility. This module is predominantly for dedicated applications.

Sensitivity: One fixed DC Range of 1 mv/inch (0.5 mv/cm).

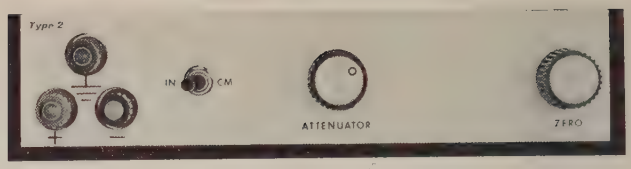
Scaling: IN/CM sw. for choice of sensitivity and paper grid.

Input Resistance: 1 megohm all conditions.

Zero: ±110% of full scale with ten turn control; friction drag prevents inadvertent movement.

Input: Universal 5 way front panel terminal; parallel remote terminal on module bottom.

Price: $60.00



TYPE 2 – DC RANGING: An inexpensive module for continuous, but non–calibrated, span adjustments.

Senisitivity: 1 mv/inch (0.5 mv/cm) continuously variable with non-calibrated ten turn control.

Scaling: IN/CM sw. for choice of sensitivity and paper grid.

Input Resistance: 100 K ohms. Fixed all conditions.

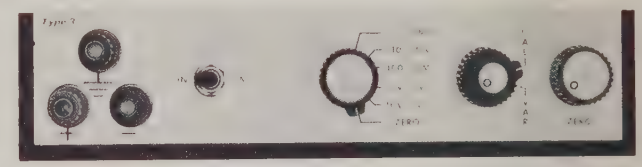
Zero: ±110% of full scale with ten turn control; friction drag prevents inadvertent movement.

Inputs: Universal 5 way front panel terminals; parallel remote terminals on module bottom.

Price: $75.00

Option: Type 2A includes 10 turn dial calibrated attenuator control.

Price: $110.00



TYPE 3 – DC SWITCHING: Moderately priced, this flexible module is ideal for everyday use. Each of its five ranges is calibrated, accurate and ultra–stable.

Sensitivity: 5 ranges of 1, 10, 100 mv/inch; 1, 10 volt/inch AND 5 Metric ranges of 0.5, 5, 50 mv/cm; 0.5, 5 volt/cm. All ranges fixed, switch selectable and calibrated; between range variable control.

Scaling: IN/CM sw. for choice of sensitivity and paper grid.

Input Resistance: 1 megohm. Fixed all conditions.

Zero: ±110% of full scale with ten turn control; friction drag prevents inadvertent movement.

Zero Check: Verifies position and allows calibration of zero without disconnecting or shorting input signal.

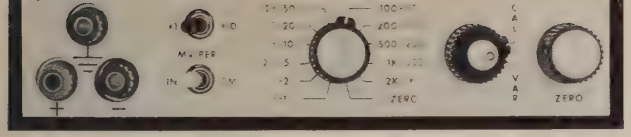
Inputs: Universal 5 way front panel terminals; parallel remote terminals on module bottom.

Price: $90.00

TYPE 4 – DC SWITCHING/TIME BASE: A perfect companion for the Type 3 Module. By flick of a switch the variable (X or Y) can be voltage attenuated or the axis driven according to time. Use on X or Y axis.

Time Base Ranges: 5 sweeps of 0.5, 1, 5, 10, 50 sec/inch AND 5 Metric sweeps of 0.25, 0.5, 2.5, 5, 25 sec/cm. All ranges fixed, switch selectable and calibrated; between range variable control.

Price: $210.00



TYPE 5 – DC PRECISION ATTENUATOR: Fourteen calibrated ranges in a 1–2–5 switching sequence. Variable control gives between range span adjustments.

Sensitivity: 14 ranges of 1, 2, 5, 10, 20, 50, 100, 200 mv/inch; 0.5, 1, 2, 5, 10, 20 v/inch AND 14 Metric ranges of 0.5, 1, 2.5, 5, 10, 25, 50, 100, 250 mv/cm; 0.5, 1, 2.5, 5, 10 volt/cm. All ranges fixed, switch selectable, and calibrated; between range variable control.

Scaling: IN/CM sw. for choice of sensitivity and paper grid.

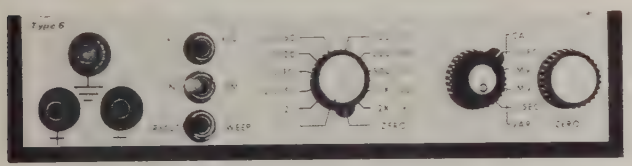
Input Resistance: 1 megohm. Fixed all conditions.

Zero: ±110% of full scale with ten turn control; friction drag prevents inadvertent movement.

Zero Check: Verifies position and allows calibration of zero without disconnecting or shorting input signal.

Inputs: Universal 5 way front panel terminals; parallel remote terminals on module bottom.

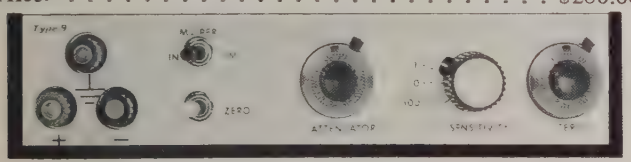
Price: $170.00



TYPE 6 – DC PRECISION ATTENUATOR/TIME BASE: All features of the Type 5 Module plus voltage ranging or time base operation at the flip of a switch.

Time Base Ranges: 11 sweeps of 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200 sec/inch AND 11 Metric sweeps of 0.05, 0.1, 0.25, 0.5, 1, 2.5, 5, 10, 25, 50 and 100 sec/cm. All ranges fixed, switch selectable, and calibrated; between range variable control.

Price: $280.00



TYPE 9 – PRECISION RANGING: Continuous calibrated scaling by means of a ten turn dial indicating attenuator. Zero control also features dial indication.

Sensitivity: 3 ranges of 1, 10, 100 mv/inch AND 3 Metric ranges of 0.5, 5, 50 mv/cm; each is fixed, calibrated, and switch selectable. Ten turn dial indicating range vernier allows precise and calibrated mid range setting.

Scaling: IN/CM sw. for choice of sensitivity and paper grid.

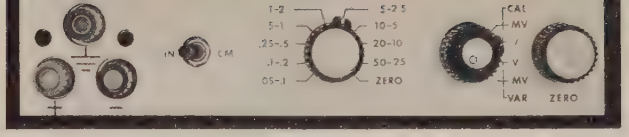
Input Resistance: 100 K ohm on 1 mv/inch. 1 megohm all other ranges. Fixed all conditions.

Zero: Ten turn zero has dial indication for precise setting.

Zero Check: Verifies position and allows calibration of zero without disconnecting or shorting input signal.

Inputs: Universal 5 way front panel terminals; parallel remote terminals on module bottom.

Price: $190.00



TYPE 7 – DC PRE–AMPLIFIER: Eighteen ranges from 100 μvolts per inch to 20 v/inch (and their Metric equivalents) give outstanding recording capabilities.

Sensitivity: 17 ranges from 0.1 millivolts to 20 volts per inch in 1–2–5– steps and 17 ranges from 0.05 millivolts to 10 volts per centimeter. All ranges fixes, switch selectable and calibrated; between range variable control.

Scaling: IN/CM sw. for choice of sensitivity and paper grid.

Input Resistance: Potentiometric all millivolt ranges. On volt ranges – 1 megohm. Fixed all conditions.

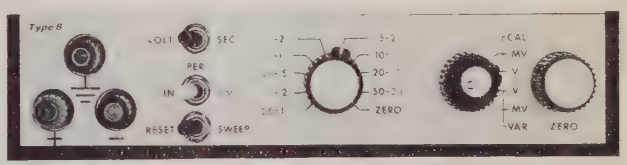
Zero: ±110% of full scale with ten turn control; friction drag prevents inadvertent movement.

Zero Check: Verifies position and allows calibration of zero without disconnecting or shorting input signal.

Zero Drift: 1 microvolt/°C after 5 minute warmup.

Inputs: Universal 5 way front panel terminals; parallel remote terminals on module bottom.

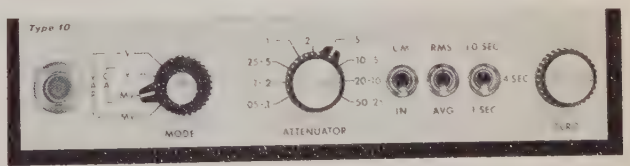
Price: $310.00



TYPE 8 – DC PRE–AMPLIFIER/TIME BASE: A combination of the high sensitivity Type 7 with a wide selection of time sweeps. It can be used for X or Y axes.

Time Base Ranges: 9 sweeps from 0.1 to 50 seconds per inch in 1–2–5 steps and 9 sweeps from 0.05 to 25 seconds per centimeter. All ranges fixed, switch selectable, and calibrated; between range variable control.

Price: $420.00



TYPE 10 – HIGH SENSITIVITY AC CONVERTER: High sensitivity of 100 μvolts/in, choice of filter time constants, and both Average and RMS scaling. SENSITIVITY, SCALING, ZERO, same as Type 7.

Input Impedance: AC coupled; 10 megohms on millivolt ranges, one megohm on volt ranges, paralleled with 100 picofarad.

Type of Input: Single ended, BNC connector, floating to 500 volts above or below chassis ground.

Calibrated Accuracy: ±0.25% F.S., 50 Hz to 50K Hz, module and plotter combined.

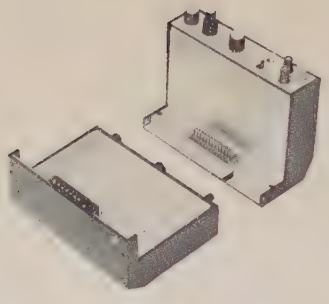
Frequency Response: ±0.1 db, 20 Hz to 100K Hz.

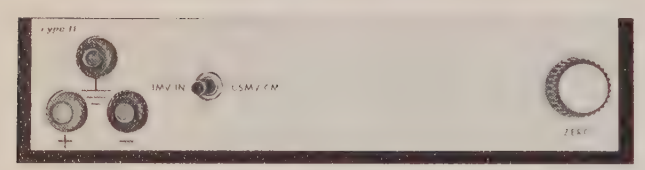
AC Offset: < 50μvolt RMS, referred to input.

Converter Time Constants: 0.1, 0.4, 1.0 seconds.

Scaling: Average and RMS (scaled for sine wave).

Price: $495.00





TYPE 11 – 1 MV FULL SCALE (10" or 250 mm): Primary use is for gas chromatograph read-out.

Sensitivity: 1 mv full scale fixed. (10" or 250 mm).

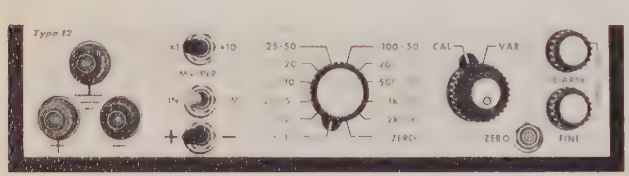
Scaling: IN/CM sw. for choice of sensitivity and paper grid.

Input Resistance: Potentiometric.

Zero: ±110% of full scale with ten turn control; friction drag prevents inadvertent movement.

Inputs: Universal 5 way front panel terminals; parallel remote terminals on module bottom.

Price: $135.00



TYPE 12 – PRECISION ATTENUATOR/OFFSET: Type 12 has 0–1 volt adjustable offset, also giving the fourteen multipurpose ranges of the Type 5 Module. Two controls give precise dial–in voltages of 0–1 volt (coarse) and 0 to 10 mv (fine). The conventional zero control is retained to preserve the identity of offset and zeroing.

Sensitivity: 14 ranges of 1, 2, 5, 10, 20, 50, 100, 200 mv/inch; 0.5, 1, 2, 5, 10, 20 v/inch AND 14 Metric ranges of 0.5, 1, 2.5, 5, 10, 25, 50, 100, 250 mv/cm; 0.5, 1, 2.5, 5, 10 volt/cm. All ranges fixed, switch selectable, and calibrated; between range variable control.

Scaling: IN/CM sw. for choice of sensitivity and paper grid.

Input Resistance: 1 megohm. Fixed all conditions.

Zero Offset: Coarse (0–1 volt) and fine (0–10 mv) ten turn controls with polarity switch.

Zero Check: Verifies position and allows calibration of zero offset without disconnecting or shorting input signal.

Offset Polarity Sw.: Determines offset polarity. Has center position for Zero Offset.

Inputs: Universal 5 way front panel terminals; parallel remote terminals on module bottom.

Price: $300.00

TYPE 15 – TWO CHANNEL DC SWITCHING: An economical way to record two data signals in a single recording channel. Attenuators and zero controls are independent, the inputs may even be of opposite polarities. Basic specifications for each channel same as Type 3 except as noted.

Input Resistance: One megohm on calibrated ranges; greater than 500K ohms uncalibrated.

Conformity: The sensitivities of the two channels differ by less than 0.1% at each of the five calibrated attenuator settings.

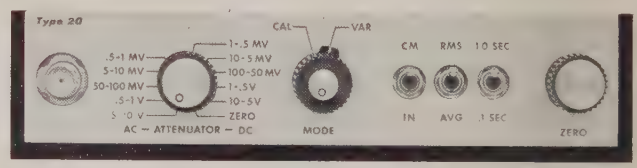
Input: Signal high, low, and ground are connected to a barrier strip at the rear of the module.

Channel Selection: Channel 1, channel 2, or both channels alternately.

Pen Control: Point: Pen is momentarily lowered at selected rate, resulting in a succession of points.
Line: Pen is alternately raised and lowered at selected rate, resulting in a succession of discontinuous line segments.
Duty Cycle: Dwell (marking) time of channel 1 can be set to 1X, 2X, or 3X that of channel 2.

Sampling Rate: Adjustable from 3 to 40 pairs of points in multiplex mode, 6 to 80 points in single channel mode, per minute.

Price: $545.00



TYPE 20 – AC and DC SWITCHING MODULE: Type 20 features the DC SENSITIVITY, SCALING, and ZERO of Type 3 plus the following AC characteristics:

Input Impedance: DC: One megohm, all conditions. AC: AC coupled, one megohm shunted by 100 picofarads, all conditions.

Type of Input: Single ended, BNC connector, floating to 500 volts above and below chassis ground.

Calibrated Accuracy: DC: ±0.2% of full scale, module and recorder combined. AC: ±0.25% of full scale, module and plotter. (VAR MODE – D.C. only).

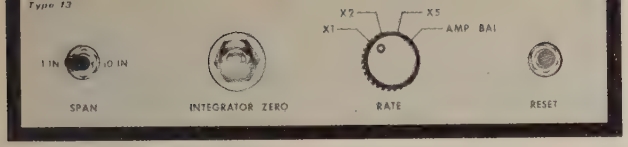
Frequency Response: (AC only) ±0.1 db, 20 Hz to 100K Hz.

AC Offset: < 50μ volts RMS, referred to input.

Converter Time Constants: 0.1 and 1.0 seconds.

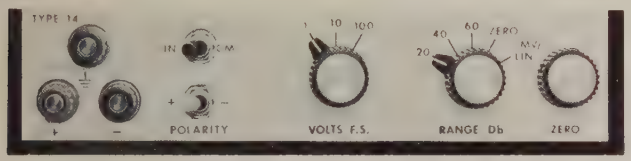
Scaling: Average and RMS (scaled for sine wave).

Price: $495.00



TYPE 13 – INTEGRATOR: Specifically intended for use in 2–3000 strip chart. Type 13 is installed in the Y2 connector, requires no external wiring. A voltage proportional to the deflection of the Y1 pen from chart zero is integrated causing the Y2 pen to be deflected at a corresponding rate. Ten inches (or 1 inch if desired) traverse. Rate of integration can be increased X2 and X5 by front panel switch.

Price: $475.00



TYPE 14 – DC LOG CONVERTER: For DC recording where resolution and dynamic range are of equal concern.

Full Scale Voltage: 1, 10, 100 volts.

Dynamic Range: 20, 40, 60 db (1, 2, 3 decades).

Conversion Accuracy: ±0.2% of range (in db).

Input Resistance: One megohm.

Input: Universal 5 way front panel terminals; parallel remote terminals on module bottom.

Price: $400.00

TYPE 16/17 – POINT PLOTTER: Chart and pen axis modules used with OMNIGRAPHIC® 3000 strip chart recorder for point plot readout of digital to analog converters in multi–channel pulse height analyzers, digital computers, and similar source of successive discrete data points.

Chart Axis:

Resolution: .025, .050, .075, .100 inches chart advance per plot.

Plot Advance Rate: 12 points/second max.

Pen Axis:

Sensitivity: 1, 10, 100 millivolts 1 and 10 volts per inch; 0.5, 5, 50 millivolts, 0.5 and 5 volts per centimeter; continuously variable vernier between ranges.

Input Resistance: One megohm constant, all conditions.

Zero: ±110% of full scale referred to chart zero.

Interface:

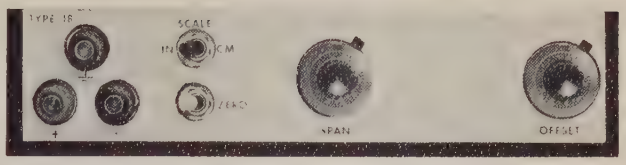
Seek Command: +3 to +12 volts or −3 to −12 volts; 0.3 μsec/volt rise time, maximum; 2 μsec. duration, minimum.

Completed Plot Command: Variable from zero to +18 or −18 volts; 0.2 μsec/volt rise time minimum; 15 milliseconds duration.

Disable Command: +3 to +12 or −3 to −12 volts.

Price: $960.00

ON THIS PAGE
SPECIAL PURPOSE MODULES



TYPE 18 – UNIVERSAL THERMOCOUPLE REFERENCE: Terminates any ISA thermocouple; continuously variable span and offset controls permit recording any 10 to 60 millivolt portion of input over full 10 inch chart span.

Thermocouple Types: Serves as reference junction for types J, K, T, E, R, and S by selection of electrical connections inside module.

Reference Temperature: 0°C.

Reference Junction Tracking Accuracy: ±0.75°C.

Span: Continuously adjustable from 10–60 millivolts. Ten turn control with 1000 count dial and lock.

Offset: 50 millivolts, continuous ten turn control with 1000 count dial and lock.

Price: $250.00

TYPE 26/17 – POINT PLOTTER: Chart (X) and pen (Y) axis point plotter modules for OMNIGRAPHIC® 2000. In addition to scaling X and Y input signals, these modules include Y axis null detector and logic to accept and generate synchronizing and pen up/down controls. Cables are available for connecting the Point Plotter to most multi–channel pulse height analyzers.

Data Inputs:

Sensitivity: X and Y axes: 1, 10, 100 millivolts, 1 and 10 volts/inch; 0.5, 5, 50 millivolts, 0.5 and 5 volt/centimeter. Continuously variable vernier between adjacent ranges.

Input Resistance: One megohm constant, all conditions.

Zero: ±110% of full scale referred to chart zero.

Interface:

Seek Command: +3 to +12 volts or −3 to −12 volts; 0.3 μsec/volt rise time, maximum; 2 μsec. duration, minimum.

Completed Plot Command: Variable from zero to +18 or −18 volts; 0.2 μsec/volt rise time minimum; 15 milliseconds duration.

Disable Command: +3 to +12 or −3 to −12 volts.

Plotting Characteristics:

Plot Modes: Calibrate, Point, Line, X–Y, Standby.

Plot Rate: 600 points per minute average, 720 points per minute maximum.

Price: $960.00

O.E.M. RECORDERS

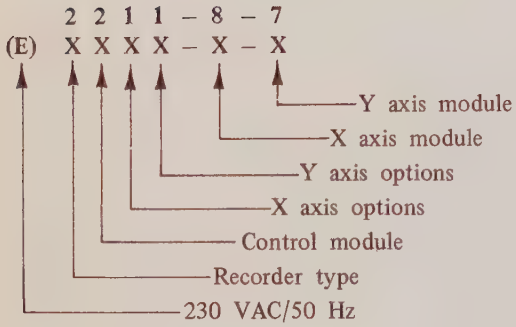
Variations of the basic OMNIGRAPHIC® 2000 X–Y and 3000 Strip Chart recorders can result in substantial savings in cost and complexity for O.E.M. and other quantity purchasers. Consult Houston Instrument or its representative for detailed information concerning any of the following recorders.

OMNIGRAPHIC® 3090 and 2–3090: The variable speed stepper motor used in 3000 and 2–3000 Strip Chart recorders is replaced by a single speed synchronous chart drive motor. The other features of these recorders are unaffected.

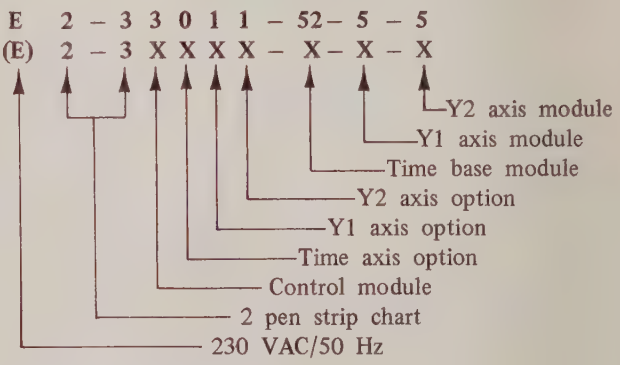
OMNIGRAPHIC® 4000 and 4090: The X axis servo system of the 2000 X–Y recorder is replaced by a stepper motor drive in the 4000 T–Y® recorder and by a single speed synchronous drive motor in 4090 T–Y® recorders. The Y axis characteristics and other features of the 2000 X–Y recorder are unaffected. These recorders combine the time base of the strip chart recorders and the compact format of the X–Y charts.

MODEL IDENTIFICATION

2000 X–Y
3000 STRIP CHART



2–3000 TWO PEN STRIP CHART


E 2 – 3 3 0 1 1 – 52 – 5 – 5
(E) 2 – 3 X X X X – X – X – X
Y2 axis module
Y1 axis module
Time base module
Y2 axis option
Y1 axis option
Time axis option
Control module
2 pen strip chart
230 VAC/50 Hz

RECORDER OPTIONS

DESIGNATOR	DESCRIPTION		PRICE
1	High speed servo: > 40 in/sec	2000 (both axes only)	$200.00
		3000 and 2–3000 (Y axis only)	100.00 per axis
2	Retransmitting Potentiometer	2000	50.00 per axis
		3000 and 2–3000 (Y axis only)	50.00 per axis
3	High Speed Servo and Retransmitting Potentiometer	2000 (both axes only)	300.00
		3000 and 2–3000 (Y axis only)	150.00 per axis
4	High–Low Limit Switches	2000	75.00 per axis
		3000 and 2–3000 (Y axis only)	75.00 per axis
5	Special Increment Size	3000 and 2–3000 (X axis only)	Factory Quote

IN ORDERING PLEASE SPECIFY

1. Recorder Model No., ie 2000 X–Y, 3000 Strip Chart
2. Control Module Type
3. X Axis Module Type
4. Y Axis (Y1 & Y2 in 2–3000) Modules
5. X Axis Options
6. Y (Y1 and Y2 in 2–3000) Options
7. 230 VAC/50 Hz Operation

RECORDING SUPPLIES

CHART PAPER

Popular papers are listed. Specify heavy or light weight when ordering.

CAT. NO.	DESCRIPTION	PRICE/100
101512	11 x 16½ with 10 x 12 major divisions	$6.00
101515	11 x 16½ with 1 inch square major grid	6.00
101538	11 x 16½ with 1 cm square major grid	6.00
34504	8½ x 11 with 1 inch square major division	5.00
81012	8½ x 11 with 10 x 12 major divisions	5.00
81015	8½ x 11 with 10 x 15 major divisions	5.00
		PRICE/Roll
RC–109	Y axis 10 major divisions in inches X axis 100 foot long, 1 inch major divisions	$3.90
RC–110	Y axis 25 cm (1 cm/major division) X axis 100 foot long, 1 inch major divisions	3.90
RC–129	Y axis 25 cm; 2.5 cm/major divisions X axis 1 cm major, 0.2 cm minor divisions 30.5 meters long	3.90
RC–115	Blank Roll 12 inches x 100 foot long	3.50

PENS

CAT. NO.	DESCRIPTION	PACKET PRICE
P–40	Packet 10 pens – red	$12.00
P–41	Packet 10 pens – blue	12.00
P–42	Packet 10 pens – green	12.00
P–43	Packet 10 pens – black	12.00
P–52	Packet 10 pens – black & red	12.00

STANDARD ACCESSORIES SUPPLIED

- Instruction Manual
- Dust Cover – Flexible
- Sample Graph Paper (10 sheets) (2000)
- Roll Chart Paper (3000)
- Accessory Kit containing:
  - 5 Red Pens
  - 5 Black Pens
  - 3 Fuses
  - Set Bristol Wrenches
- 8½ X 11 (or A4) Shield (2000)

Warranty

Houston Instrument warrants unconditionally for 1 year from date of shipment each instrument manufactured by it to be free from defects in material and workmanship. Its liability under this warranty is limited to servicing or adjusting any instrument returned by the original purchaser to the factory for that purpose and to replace any defective parts therein.

REPRESENTED BY

houston instrument | DIVISION OF BAUSCH & LOMB

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"the recorder company"

Bulletin 2&3272

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Printed in USA

ADDENDUM

This will replace DETAIL DESCRIPTION located on pages 12, 13 and 14.

DETAIL DESCRIPTION: The input signal from the module is applied to Pin 22 on the amplifier connector, through R4 to an integrated circuit chopper, IC1. The rebalance feedback signal is applied to the chopper vis Pin 16 and R1. This feedback signal originates at the rebalance potentiometer (driven mechanically by the servo system), and prior to scaling appears at Pin 10. Loading of the rebalance pot is eliminated by use of a high input impedance buffer amplifier (1/2 IC4). A divider network composed of R31 through R36 attenuates the rebalance signal to a level of 1 mv change for each 1 inch (or 2 cm) increment of pen movement. The output of this divider appears at Pin 15, and is further divided and loaded by two external resistors. English calibration (1 mv/in) is obtained by connecting Pin 16 to point A; metric calibration (0.5 mv/cm) is obtained by connecting Pin 16 to point B. Pin 11 is connected to a junction (point C) higher in the divider string, and is used for external variable attenuation. Capacitors C16 and C20 provide electrical damping of the servo response. Resistor R34 is the summing resistor for the Zero pot.

The input and rebalance signals are compared and modulated by IC1, a DPDT chopper, producing two square wave error signals. These two signals are differentially amplified by a preamplifier composed of C4–7, R5–9, R24, Q1 and IC3.

The output of this preamplifier appears at Pin 6 of IC3. The A.C. gain is controlled by feedback which travels through an external divider via Pin 6 (point E) and Pin 13 (point F) and then through R9 to the non–inverting input of IC3. The gain is determined approximately by the product of the ratio of the external divider and the ratio of R9 to R8. The external divider provides external gain control which is required for various control functions in the input modules.

The output of the preamplifier passes through C8 and the internal gain control, R38, to the input of a full wave demodulator composed of 1/3 IC2, R16–18, and R39. IC2 is composed of 3 pairs of complementary MOS FET's (C–MOS). One of these pairs is connected in such a way as to alternately connect the amplified error signal to first one and then the other input of a differential amplifier, 1/2 IC4. This yields two signals, each displaying only one–half of each cycle of error signal. These two outputs are summed algebraically and amplified by IC4. The result is a full wave demodulated representation of the error signal, which is now a D.C. signal.

The new D.C. error signal is buffered by a complementary Darlington configuration composed of Q2 and Q3. The output of the power stage is applied directly to the servo motor and to a non–linear feedback network composed of R22, R23, R25, R26, C14, CR5, and CR6. The purpose of this network is (1), to control the gain of the amplifier – demodulator section so that on part of the total servo is operating "open–loop" or without feedback stabilization of temperature, voltage and aging effects and (2), to provide the "dead zone compensation" mentioned in the general description. The transfer characteristics of this network are such that the incremental gain of the servo amplifier is highest at null, and therefore static errors due to dead zone are reduced or eliminated.

A power protection circuit is provided to limit dissipation in the servo motor. This circuit is composed of Q4, Q5, CR7, CR8, R27–30, and C15. The purpose of this circuit is to reduce the voltage applied to the servo motor after the pen has been driven against the mechanical stops for more than a few seconds. With zero volts present at the output of IC4 (and therefore at the motor), then neither Q4 or Q5 is turned on. If the output of IC4 swings to approximately ±6VDC or more, the voltage at the base of Q4 will gradually rise (at a rate determined by R29 and C15) to about 0.5VDC which causes Q4 to sink current through CR7 and R30 thus reducing the voltage at the bases of Q2 and Q3. Q5 conducts similarly for negative output voltage.

The chopper and demodulator are driven by an oscillator composed of 2/3 IC2, R10, R11, and C9. This is a common astable multi–vibrator whose frequency (approximately 1kh) is determined by the time constant of R10 and C9. In addition to driving the chopper and demodulator, the oscillator output is connected to a network composed of R2, R3, R37, and C3 which is adjusted to cancel the offset current generated by the chopper.

The reference supplies for the rebalance and zero voltages are derived from CR1 and CR2, which are highly stable temperature compensated zener diodes. CR3 and CR4 provide regulation of the bias supplies needed to operate IC1, IC2, and IC3. The operating current for these regulators is supplied by the 15 volt supplies located on the power supply board.

houston
instrument

April 22, 1974

4950 TERMINAL AVENUE, BELLAIRE, TEXAS 77401 • TELEPHONE 713 667-7403/RESEARCH & DEVELOPMENT 713 667-9307

Dear Recorder User:

The attached amplifier sheets supercedes what is in your present instruction manual. These sheets should be kept with your manual for reference.

Very truly yours,

L. C. Bower

L. C. Bower
General Sales Manager

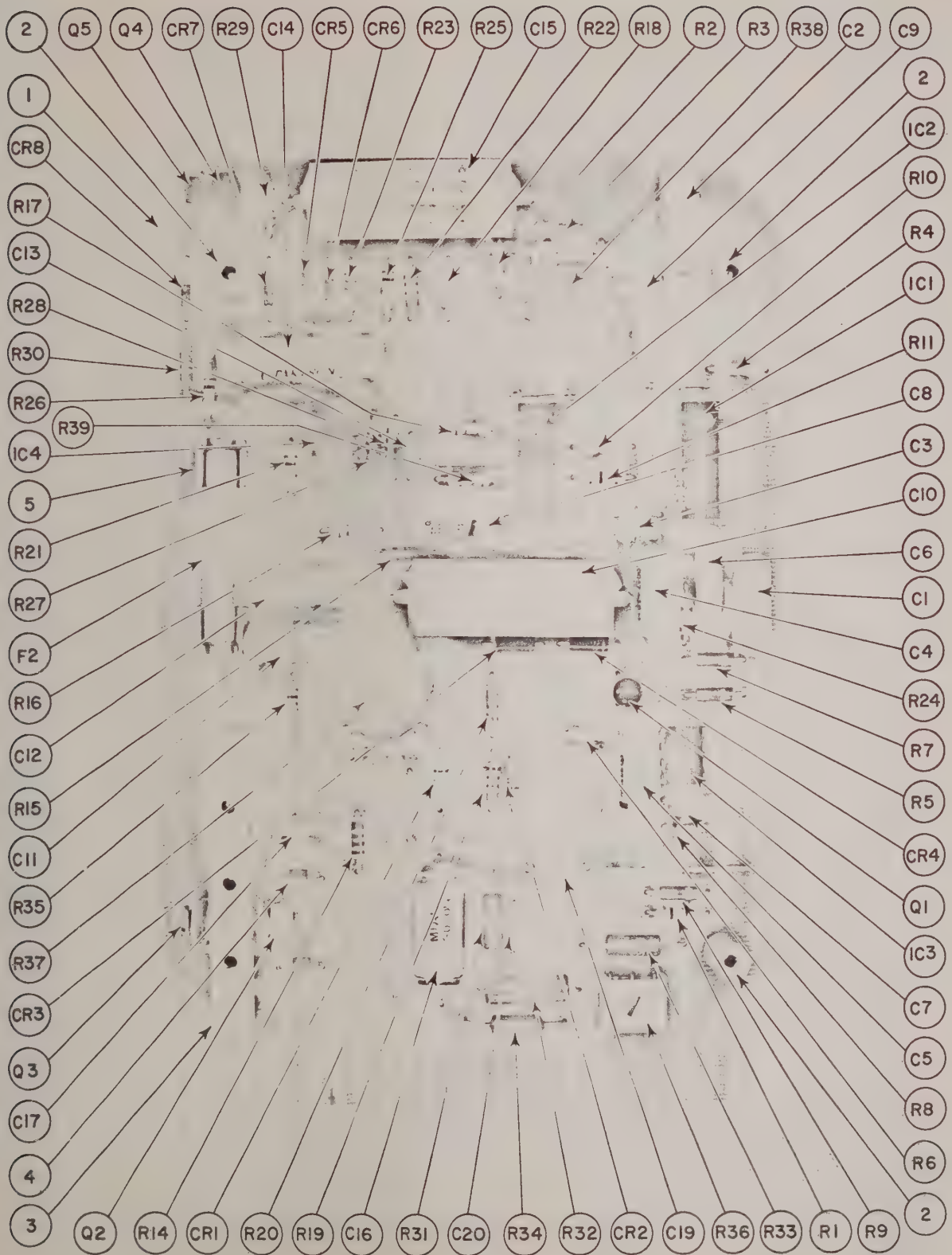
LCB/hd

Enclosures: Amplifier Sheet

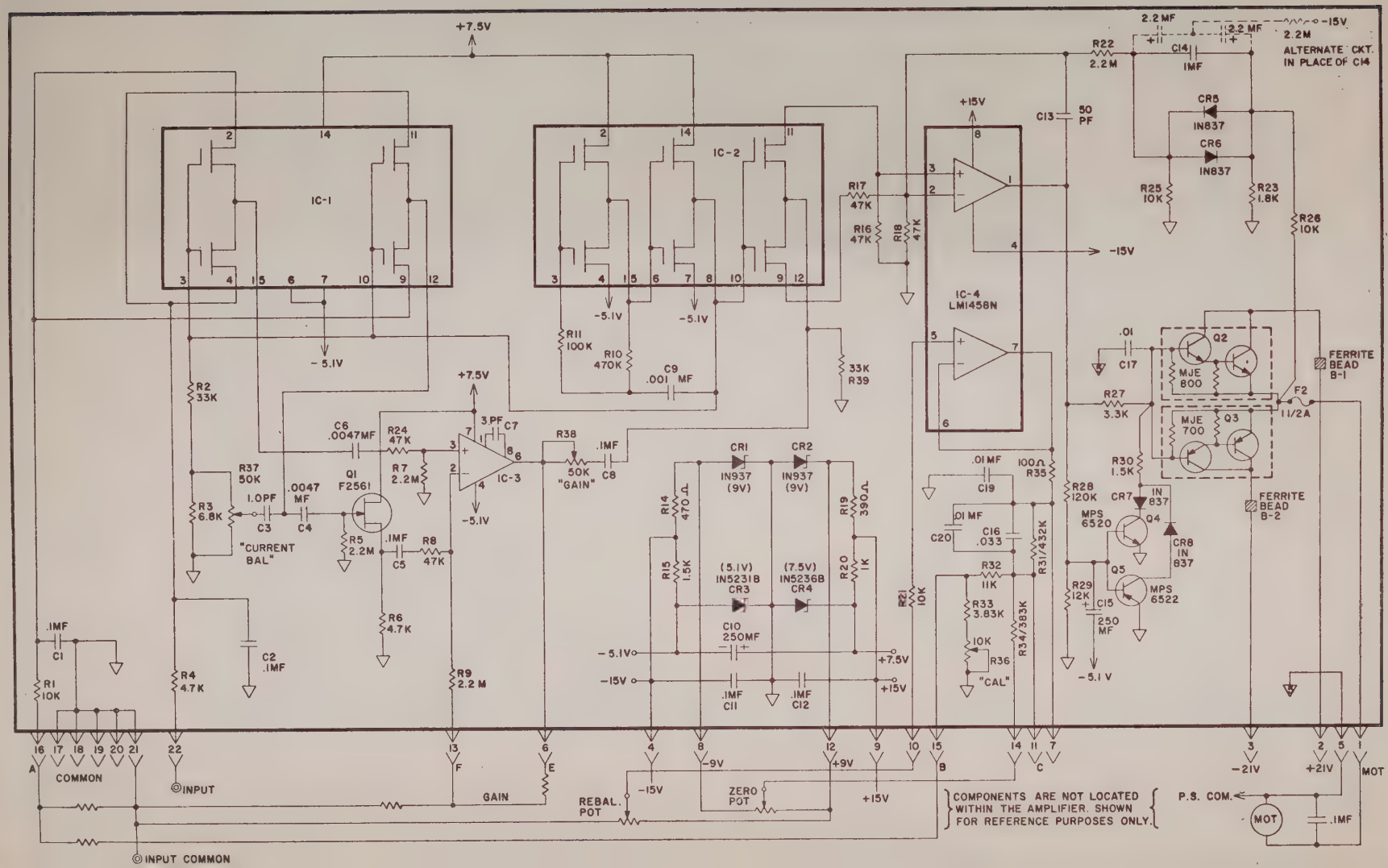
DIVISION OF BAUSCH & LOMB

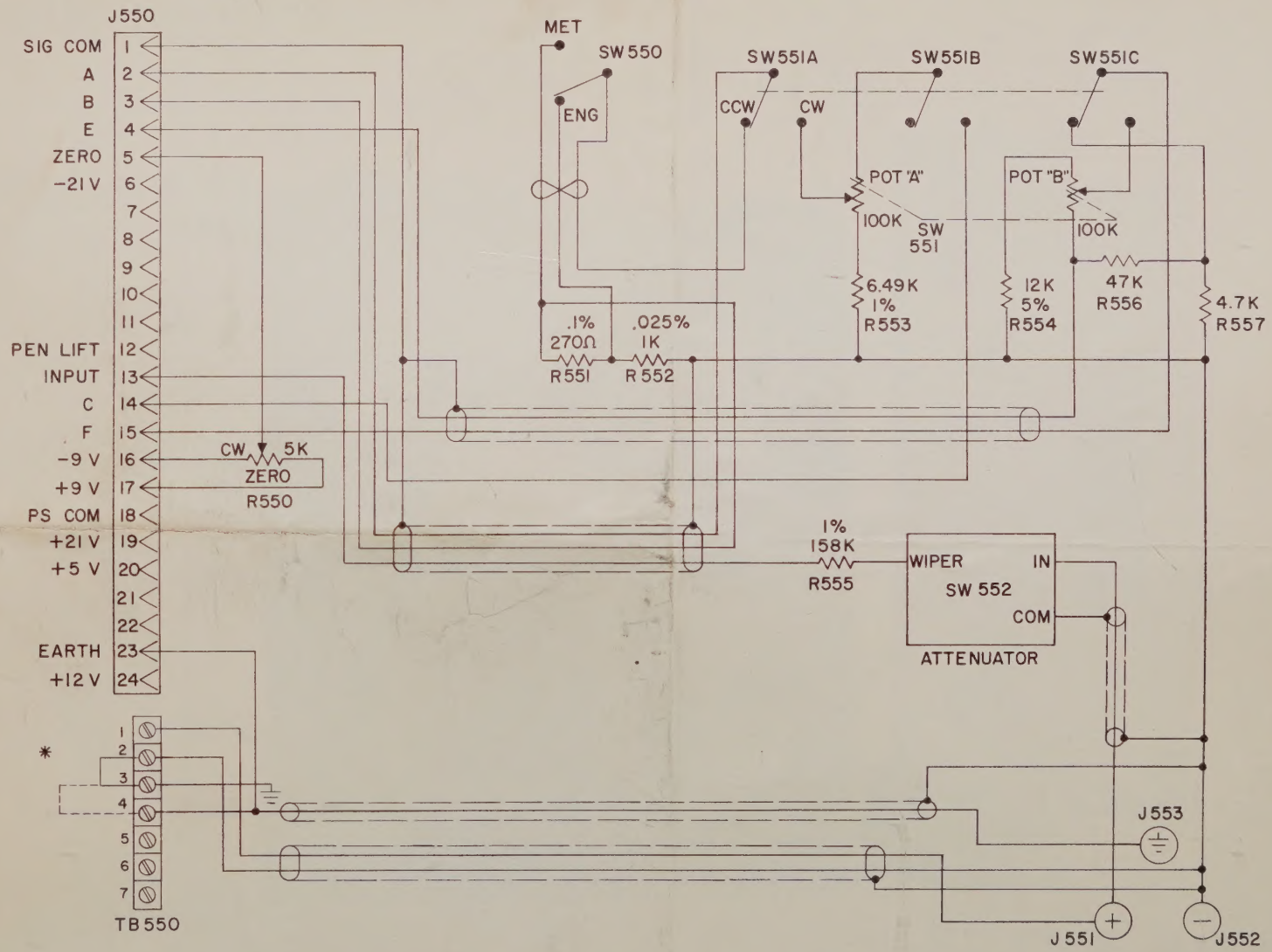
AMPLIFIER PARTS LIST

SCHEMATIC REF. NO.	HOUSTON INSTRUMENT PART NO.	DESCRIPTION	TOTAL USED	MANUFACTURER
0	2000-263	Circuit Board - Assembly	1	Houston Instrument
1	2000-177	Circuit Board	1	Houston Instrument
2	2000-53	Standoff	3	Houston Instrument
3	2000-397	Heat Sink	1	Houston Instrument
4	2000-49	Cover (Not Shown)	1	Houston Instrument
5	MF-60	Fuse Clip	2	Zierick
		BEADS		
B-1	MB-118	Ferrite Bead	2	Ferroxcube
B-2		Same As B-1		
		CAPACITORS		
C-1	MC-261	.1 MFD - 1000V - 10% - Ceramic	6	Sprague
C-2		Same As C-1		
C-3	MC-360	1.0 PFD - NPO Temp Coeff.	1	Sprague
C-4	MC-361	.0047 MFD - 100V - Ceramic	2	Sprague
C-5		Same As C-1		
C-6		Same As C-4		
C-7	MC-403	3 PFD - 1000V - 20% - Ceramic	1	Sprague
C-8		Same As C-1		
C-9	MC-402	.001 MFD - 10% - 225P10291	1	Sprague
C-10	MC-362	250 MFD - 15V - Pacer	2	Mallory
C-11		Same As C-1		
C-12		Same As C-1		
C-13	MC-102	50 PFD - 200V - 10% - Dura Mica	1	Sterling
C-14	MC-157	1 MFD - 200V - 20% - Mylar	1	Paktron
C-15		Same As C-10		
C-16	MC-363	.033 MFD - 5% - 50V - Mylar	1	Parvin
C-17	MC-229	.01 MFD - 100V - 20% - Ceramic	3	Sprague
C-18		Unassigned		
C-19		Same As C-17		
C-20		Same As C-17		
		DIODES		
CR-1	MD-10	1N937	2	Motorola
CR-2		Same As CR-1		
CR-3	MD-113	1N5231B	1	Motorola
CR-4	MD-120	1N5236B	1	Motorola
CR-5	MD-8	1N837	4	ITT
CR-6		Same As CR-5		
CR-7		Same As CR-5		
CR-8		Same As CR-5		
		FUSE		
F-2	MF-32	1½ Amp - 3 AG	1	Littlefuse
		INTEGRATED CIRCUIT		
IC-1	MW-224	Integrated Circuit	1	HI
IC-2	MW-206	Integrated Circuit	1	HI
IC-3	MW-227	Integrated Circuit	1	HI
IC-4	MW-181	LM1458N	1	National
		TRANSISTORS		
Q-1	MQ-48	F2561	1	Solitron
Q-2	MQ-75	MJE800	1	Motorola
Q-3	MQ-74	MJE700	1	Motorola
Q-4	MQ-26	MPS6520	1	Motorola
Q-5	MQ-27	MPS6522	1	Motorola
		RESISTORS		
R-1	MR-470	10K - 1/3W - 5% - Carbon Film	4	Mepco-Electra
R-2	MR-481	33K - 1/3W - 5% - Carbon Film	2	Mepco-Electra
R-3	MR-474	6.8K - 1/3W - 5% - Carbon Film	1	Mepco-Electra
R-4	MR-979	4.7K - 1/3W - 5% - Carbon Film	2	Mepco-Electra
R-5	MR-980	2.2 Meg - 1/3W - 5% - Carbon Film	4	Mepco-Electra
R-6		Same As R-4		
R-7		Same As R-5		
R-8	MR-964	47K - 1/3W - 5% - Carbon Film	5	Mepco-Electra
R-9		Same As R-5		
R-10	MR-145	470K - 1/3W - 5% - Carbon Film	1	Mepco-Electra
R-11	MR-310	100K - 1/3W - 5% - Carbon Film	1	Mepco-Electra
R-12		Unassigned		
R-13		Unassigned		
R-14	MR-972	470 Ohm - 1/3 - 5% - Carbon Film	1	Mepco-Electra
R-15	MR-483	1.5K - 1/3W - 5% - Carbon Film	2	Mepco-Electra
R-16		Same As R-8		
R-17		Same As R-8		
R-18		Same As R-8		
R-19	MR-170	390 Ohm - 1/3W - 5% - Carbon Film	1	Mepco-Electra
R-20	MR-963	1K - 1/3W - 5% - Carbon Film	1	Mepco-Electra
R-21		Same As R-1		
R-22		Same As R-5		
R-23	MR-839	1.8K - 1/3W - 5% - Carbon Film	1	Mepco-Electra
R-24		Same As R-8		
R-25		Same As R-1		
R-26		Same As R-1		
R-27	MR-978	3.3K - 1/3W - 5% - Carbon Film	1	Mepco-Electra
R-28	MR-844	120K - 1/3W - 5% - Carbon Film	1	Mepco-Electra
R-29	MR-177	12K - 1/3W - 5% - Carbon Film	1	Mepco-Electra
R-30		Same As R-15		
R-31	MR-1221	432K - 1/2W - 1% - Metal Film	1	Corning
R-32	MR-239	11K - 1/2W - 1% - Metal Film	1	Corning
R-33	MR-1025	3.83K - 1/2W - 1% - Metal Film	1	Corning
R-34	MR-1026	383K - 1/2W - 1% - Metal Film	1	Corning
R-35	MR-823	100 Ohm - 1/3W - 5% - Carbon Film	1	Mepco-Electra
R-36	MP-381	Pot. 10K - 360T103B	1	CTS
R-37	MP-433	Pot. 50K - U201	2	CTS
R-38		Same As R-37		


2
Q5
Q4
CR7
R29
C14
CR5
CR6
R23
R25
C15
R22
R18
R2
R3
R38
C2
C9
1
CR8
R17
C13
R28
R30
R26
R39
IC4
5
R21
R27
F2
R16
C12
R15
C11
R35
R37
CR3
Q3
C17
4
3
2
IC2
R10
R4
IC1
R11
C8
C3
C10
C6
C1
C4
R24
R7
R5
CR4
Q1
IC3
C7
C5
R8
R6
2
Q2
R14
CR1
R20
R19
C16
R31
C20
R34
R32
CR2
C19
R36
R33
R1
R9

AMPLIFIER

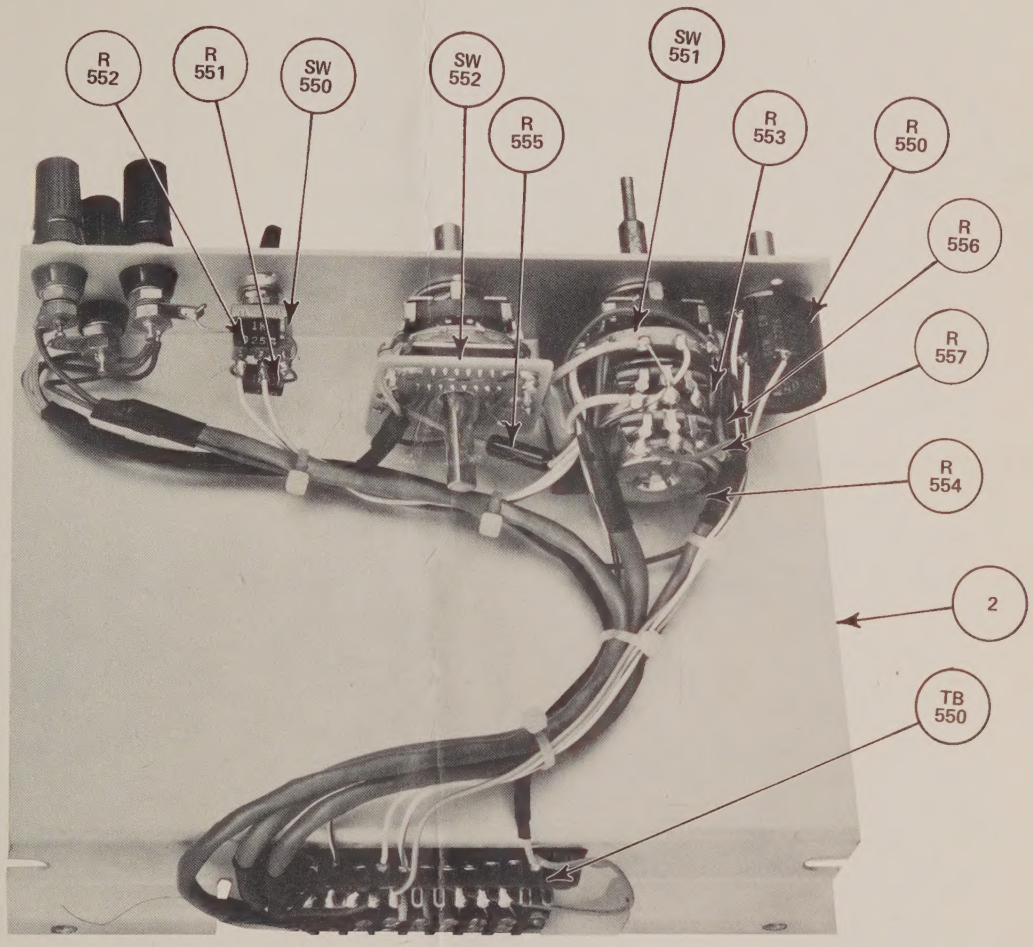

+7.5V
IC-1
IC-2
IC-3
IC-4
LM1458N
-5.1V
-15V
+15V
R1 10K
R2 33K
R3 6.8K
R4 4.7K
R5 2.2M
R6 4.7K
R7 2.2M
R8 47K
R9 2.2 M
R10 470K
R11 100K
R14 470Ω
R15 1.5K
R16 47K
R17 47K
R18 47K
R19 390Ω
R20 1K
R21 10K
R22 2.2M
R23 1.8K
R24 47K
R25 10K
R26 10K
R27 3.3K
R28 120K
R29 12K
R30 1.5K
R31/432K
R32 11K
R33 3.83K
R34/383K
R35 100Ω
R36 10K "CAL"
R37 50K "CURRENT BAL"
R38 50K "GAIN"
R39 33K
C1 .1MF
C2 .1MF
C3 1.0PF
C4 .0047 MF
C5 .1MF
C6 .0047MF
C7 3PF
C8 .1MF
C9 .001 MF
C10 250MF
C11 .1MF
C12 .1MF
C13 50 PF
C14 1MF
C15 250 MF
C16 .033
C17 .01
C19 .01 MF
C20 .01 MF
2.2 MF
2.2M ALTERNATE CKT. IN PLACE OF C14
CR1 IN937 (9V)
CR2 IN937 (9V)
CR3 (5.1V) IN5231B
CR4 (7.5V) IN5236B
CR5 IN837
CR6 IN837
CR7 IN 837
CR8 IN 837
Q1 F2561
Q2 MJE 800
Q3 MJE 700
Q4 MPS 6520
Q5 MPS 6522
F2 1 1/2A
FERRITE BEAD B-1
FERRITE BEAD B-2
A
COMMON
INPUT
INPUT COMMON
F
GAIN
E
REBAL. POT
ZERO POT
-9V
+9V
B
C
-21V
+21V
MOT
P.S. COM.
COMPONENTS ARE NOT LOCATED WITHIN THE AMPLIFIER. SHOWN FOR REFERENCE PURPOSES ONLY.

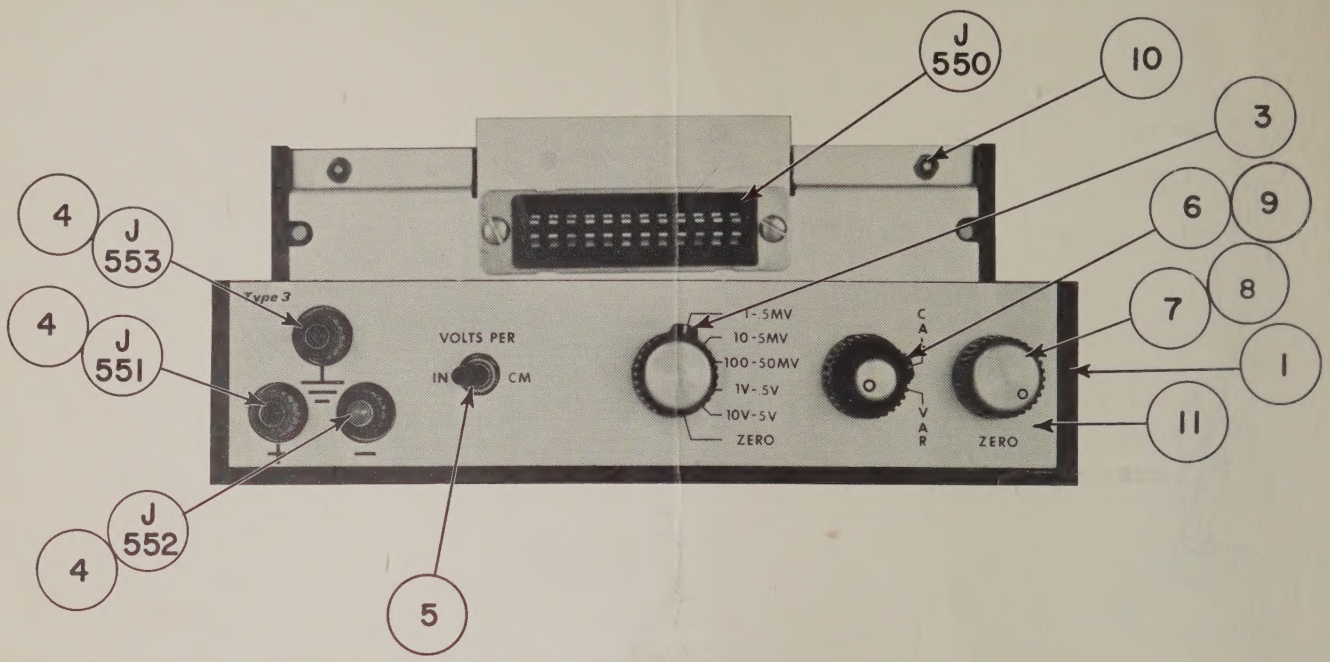


* NORMAL JUMPER FOR MAXIMUM COMMON MODE SIGNAL REJECTION. RECONNECT AS ALTERNATELY INDICATED IF COMMON MODE VOLTAGE ASSUMES HAZARDOUS LEVELS.

TYPE 3

C-SK-3208


R 552
R 551
SW 550
SW 552
R 555
SW 551
R 553
R 550
R 556
R 557
R 554
2
TB 550

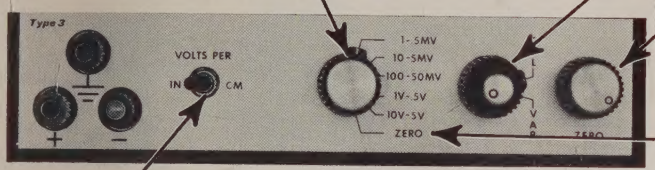


REFERENCE NUMBER	HOUSTON INSTRUMENT STOCK NUMBER	QUAN.	DESCRIPTION	MANUFACTURER & PART NUMBER
1	2000–227	1	Case Moulding – Machined	Houston Instrument
2	2000–317	1	Chassis – Machined	Houston Instrument
3	MK–4	1	Knob – Black	Buckeye PS–70–PL–2
4	2000–374	3	Insulator – Binding Post	Houston Instrument
5	MK–31	1	Knob – Black	Alco No. C–10
6	MK–30	1	Knob – Black	Buckeye PS–50D–1
7	MK–3	1	Knob – Black	Buckeye PS–70D–2
8	95–356	1	Shaft Lock	Houston Instrument
9	MK–29	1	Knob – Black	Buckeye PS–70CPL–2
10	2000–4	2	Alignment Post – Module	Houston Instrument
11	2000–237	1	Decal – Front Panel	Houston Instrument
J550	MC–835	1	Connector	Amphenol 26–4100–24P
J551	MB–94	1	Binding Post – Red	Superior DF–21–RC
J552	MB–95	1	Binding Post – Black	Superior DF–21–BC
J553	MB–96	1	Binding Post – Green	Superior DF–21–GNC
R550	MP–385	1	Pot – 5K	Duncan 3253–5K
R551	MR–1005	1	Resistor – 270 ohm – 0.1% – 1/4W – WW	Gamble
R552	MR–1006	1	Resistor – 1K – .025% – 1/4W – WW	Gamble
R553	MR–991	1	Resistor – 6.49K – 1% – 1/2W – MF	Texas Instrument
R554	MR–177	1	Resistor –12K – 5% – 1/3W – Comp	Allen Bradley
R555	MR–501	1	Resistor – 158K – 1% – 1/2W – MF	Texas Instrument
R556	MR–964	1	Resistor – 47K – 5% – 1/3W – Carbon Film	Mepco/Electra
R557	MR–979	1	Resistor – 4.7K – 5% – 1/3W – Carbon Film	Mepco/Electra
SW550	MS–351	1	Switch – SPDT	Alcon MST 1050
SW551	MS–357	1	Switch – W/Pot assembly	CTS 2193
SW552	MS–370C	1	Switch – Attenuator	Houston Instrument
TB550	MB–109	1	Barrier Strip	Cinch Jones 7–172

Module Serial No. _____

TYPE 3
INPUT MODULE
DC SWITCHING

ATTENUATOR: Five ranges of 1, 10, 100 mv/inch; 1, 10 volt/inch and five Metric ranges of 0.5, 5, 50 mv/cm; 0.5, 5 volt/cm depending on the scaling switch. Each range has a fixed sensitivity and is calibrated.



IN/CM: Allows ideal scaling flexibility, making the recorder independent of the two types of conventional grids (inches or centimeters).

CIRCUIT DESCRIPTION: The input signal is fed directly to the six position attenuator switch with a total input resistance of 1 megohm. This divider is composed of equal value resistors which have constant temperature effects and which add equally to R–555 to give a constant input resistance to the amplifier. P–550 is used across the +9 and –9 reference voltage as a zero control.

SW–550 and resistors R–551 and R–552 act as a switchable but fixed voltage divider for the choice of 1 mv/inch or 0.5 mv/cm sensitivity. When SW–552 is in the CAL position resistor R–554 and the adjacent 100K pot set the amplifier open loop gain. In the VAR mode calibration is determined by R–553 and the incremental resistance of its adjacent 100K pot. The open loop amplifier gain of the mating section is varied correspondingly.

CAL/VAR–VERNIER: A concentric control. Setting the bottom knob to CALibrate fixes the sensitivity according to the attenuator position. In VARiable, the top vernier knob allows between range sensitivity setting. Turning CW decreases sensitivity. At the extreme positions, sensitivity is equivalent to highest attenuator sensitivity setting or to somewhat less than the next lower attenuator setting, i.e., complete range overlap.

ZERO: Ten turn control of pen origin. ±110% adjustment is independent of sensitivity. Friction drag prevents inadvertent movement.

ZERO CHECK: A "sixth" position of the attenuator switch. This setting places a short across the recorder's amplifier input without disturbing the input signal. The pen then progresses to an "electrical" zero position. This excursion represents the amount of base offset inherent in the input variable. Direct calibration is possible by the product of Δ D (chart distance moved) x Sensitivity.

INPUT RESISTANCE: 1 megohm. Offers a constant resistance independent of source changes and recorder's null, slewing or offset condition.

INPUT CHARACTERISTICS: Differential and floating up to ±500 VDC or peak AC from ground.

COMMON MODE: For maximum rejection module chassis is connected to signal minus at rear terminal strip. Should hazardous common mode voltage levels be present reconnect jumper from chassis to earth ground as shown in accompanying schematic.

OTHER CHARACTERISTICS: Accuracy, CMR, reference, environmental, etc. are equivalent to the recorder mainframe specifications, to which the module offers no degradation.

houston instrument | DIVISION OF **BAUSCH & LOMB**

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EUROPEAN HEADQUARTERS Rochesterlaan 6 8240 Gistel Belgium
Phone 059/277445 Telex Bausch 81399

"the graphics-recorder company"

TYPE 3 978 I–52

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